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September 7, 2012

Ooma, Inc.
1840 Embarcadero Road
Palo Alto, CA 94303

Dear Michal Smulski,

Enclosed is the EMC Wireless test report for compliance testing of the Ooma, Inc., Ooma Wireless Adapter as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15, Subpart B, ICES-003, Issue 4 February 2004 for a Class B Digital Device and FCC Part 15 Subpart C, RSS-210, Issue 8, Dec. 2010 for Intentional Radiators.

Thank you for using the services of MET Laboratories, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,
MET LABORATORIES, INC.

Jennifer Warnell
Documentation Department

Reference: (\Ooma, Inc.\EMCS34997-FCC247 Rev. 1)

Electromagnetic Compatibility Criteria
Test Report

for the

Ooma, Inc.
Ooma Wireless Adapter

Tested under
the FCC Certification Rules
contained in
Title 47 of the CFR, Parts 15 Subpart B & ICES-003
for Class B Digital Devices
&
15.247 Subpart C & RSS-210, Issue 8, Dec. 2010
for Intentional Radiators

MET Report: EMCS34997-FCC247 Rev. 1

September 7, 2012

Prepared For:

Ooma, Inc.
1840 Embarcadero Road
Palo Alto, CA 94303

Prepared By:
MET Laboratories, Inc.
3162 Belick St.
Santa Clara, CA 95054

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for Intentional Radiators

Anderson Soungpanya, Project Engineer
Electromagnetic Compatibility Lab

Jennifer Warnell
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules Parts 15B, 15.247 and Industry Canada standards ICES-003, Issue 4 February 2004, RSS-210, Issue 8, Dec. 2010 under normal use and maintenance.

Shawn McMillen,
Wireless Manager, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	June 14, 2012	Initial Issue.
1	September 7, 2012	Revised to reflect engineer corrections.

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List of Terms and Abbreviations

AC	**A**lternating **C**urrent
ACF	**A**ntenna **C**orrection **F**actor
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**D**eci**b**els
dBµA	**D**eci**b**els above one **micro**amp
dBµV	**D**eci**b**els above one **micro**volt
dBµA/m	**D**eci**b**els above one **micro**amp **per m**eter
dBµV/m	**D**eci**b**els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
ESD	**E**lectro**s**tatic **D**ischarge
EUT	**E**quipment **U**nder **T**est
f	**F**requency
FCC	**F**ederal **C**ommunications **C**ommission
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
HCP	**H**orizontal **C**oupling **P**lane
Hz	**H**ert**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**h**ert**z**
kPa	**k**ilo**pa**scal
kV	**k**ilo**v**olt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**h**ertz
µH	**microh**enry
µ	**microf**arad
µs	**micros**econds
NEBS	**N**etwork **E**quipment-**B**uilding **S**ystem
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
TWT	**T**raveling **W**ave **T**ube
V/m	**V**olts **per m**eter
VCP	**V**ertical **C**oupling **P**lane

I. Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Ooma, Inc. Ooma Wireless Adapter, with the requirements of Part 15, §15.247. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the Ooma Wireless Adapter. Ooma, Inc. should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Ooma Wireless Adapter, has been **permanently** discontinued.

B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, §15.247, in accordance with Ooma, Inc., purchase order number 3234. All tests were conducted using measurement procedure ANSI C63.4-2003.

FCC Reference 47 CFR Part 15.247:2005	IC Reference RSS-210 Issue 8: 2010; RSS-GEN Issue 3: 2010	Description	Compliance
47 CFR Part 15.107 (a)	ICES-003 Issue 4 February 2004	Conducted Emission Limits for a Class B Digital Device	Compliant
47 CFR Part 15.109 (a)	ICES-003 Issue 4 February 2004	Radiated Emission Limits for a Class B Digital Device	Compliant
Title 47 of the CFR, Part 15 §15.203	N/A	Antenna Requirement	Compliant
Title 47 of the CFR, Part 15 §15.207(a)	RSS-GEN (7.2.4)	Conducted Emission Limits	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(2)	RSS-Gen(4.6)	6dB Occupied Bandwidth	Compliant
		99% Occupied Bandwidth	Compliant
Title 47 of the CFR, Part 15 §15.247(b)	RSS-210(A8.4)	Peak Power Output	Compliant
Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205	RSS-210(A8.5)	Radiated Spurious Emissions Requirements	Compliant
Title 47 of the CFR, Part 15 §15.247(d)	RSS-210(A8.5)	RF Conducted Spurious Emissions Requirements	Compliant
Title 47 of the CFR, Part 15 §15.247(d)	RSS-210(A8.5)	RF Conducted Band Edge	Compliant
Title 47 of the CFR, Part 15; §15.247(e)	RSS-210(A8.2)	Peak Power Spectral Density	Compliant
Title 47 of the CFR, Part 15 §15.247(i)	RSS-Gen(5.6)	Maximum Permissible Exposure (MPE)	Compliant
N/A	RSS-Gen(4.10)	Receiver Spurious Emissions	Compliant

Table 1. Executive Summary of EMC Part 15.247 ComplianceTesting

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Ooma, Inc. to perform testing on the Ooma Wireless Adapter, under Ooma, Inc.'s purchase order number 3234.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Ooma, Inc., Ooma Wireless Adapter.

The results obtained relate only to the item(s) tested.

Model(s) Tested:	Ooma Wireless Adapter	
Model(s) Covered:	Ooma Wireless Adapter	
EUT Specifications:	Primary Power: 5 VDC (USB Power)	
	FCC ID: XFT-OOMAWIFI100 IC: 9769A-OOMAWIFI100	
	Type of Modulations:	DSSS; OFDM
	Equipment Code:	DTS
	Peak RF Output Power:	24.93 dBm
	EUT Frequency Ranges:	2412-2462MHz
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35º C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Anderson Soungpanya	
Report Date(s):	September 7, 2012	

Table 2. EUT Summary Table

B. References

CFR 47, Part 15, Subpart C	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies
CFR 47, Part 15, Subpart B	Electromagnetic Compatibility: Criteria for Radio Frequency Devices
RSS-210, Issue 8, Dec. 2010	Low-power Licence-exempt Radiocommunications Devices (All Frequency Bands): Category I Equipment
RSS-GEN, Issue 3, Dec. 2010	General Requirements and Information for the Certification of Radio Apparatus
ICES-003, Issue 4 February 2004	Electromagnetic Compatibility: Criteria for Radio Frequency Devices
ANSI C63.4:2003	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI/NCSL Z540-1-1994	Calibration Laboratories and Measuring and Test Equipment - General Requirements
ANSI/ISO/IEC 17025:2000	General Requirements for the Competence of Testing and Calibration Laboratories
ANSI C63.10-2009	American National Standard for Testing Unlicensed Wireless Devices

Table 3. References

C. Test Site

All testing was performed at MET Laboratories, Inc., 3162 Belick St., Santa Clara, CA 95054. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a 5 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories.

D. Description of Test Sample

The Ooma, Inc. Ooma Wireless Adapter, Equipment Under Test (EUT), is a USB wireless dongle that support 802.11b/g/n protocols.

Photograph 1. Ooma, Inc. Ooma Wireless Adapter

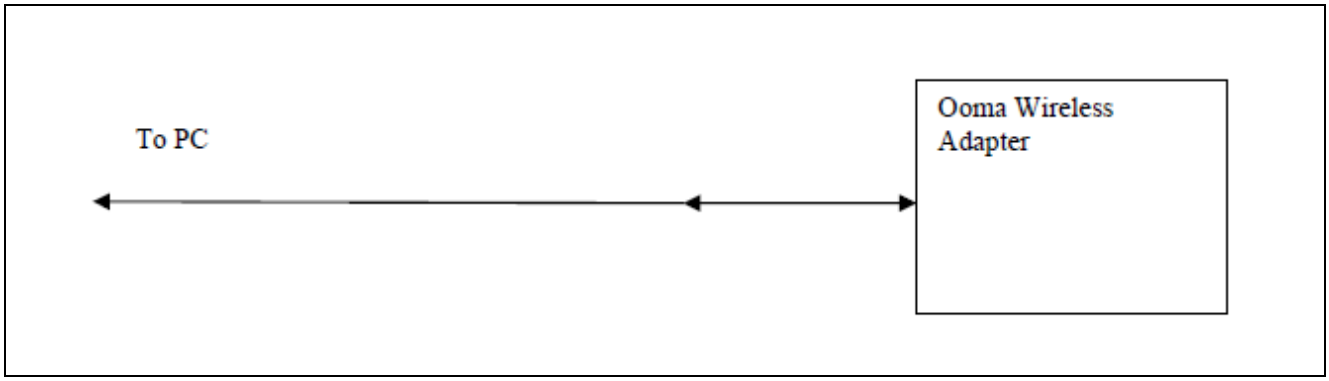


Figure 1. Block Diagram of Test Configuration

E. Equipment Configuration

The EUT was set up as outlined in Figure 1, Block Diagram of Test Setup. All cards, racks, etc., incorporated as part of the EUT is included in the following list.

Ref. ID	Name / Description	Model Number	Serial Number
NA	Ooma Wireless Adapter	TELO AIR	E091534EC51C

Table 4. Equipment Configuration

F. Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

Ref. ID	Name / Description	Manufacturer	Model Number	Serial Number
NA	Laptop	Sony	PCG-6N2L	28247233 3003053

Table 5. Support Equipment

G. Ports and Cabling Information

Ref. ID	Port Name on EUT	Cable Description	Qty.	Length (m)	Shielded (Y/N)	Termination Point
NA	USB	Direct Connection	1	NA	NA	USB on Laptop

Table 6. Ports and Cabling Information

H. Mode of Operation

The EUT was connected via USB to a Laptop. Engineering only software was provided to control the EUT to set Channels, Power, Modulation Etc. EUT can operate in the following modes: 802.11 b/g/n.

I. Method of Monitoring EUT Operation

Engineering only software was provided to monitor the EUT.

J. Modifications

a) Modifications to EUT

No modifications were made to the EUT.

b) Modifications to Test Standard

No modifications were made to the test standard.

K. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Ooma, Inc. upon completion of testing.

III. Electromagnetic Compatibility Criteria for Unintentional Radiators

Electromagnetic Compatibility Criteria

§ 15.107 Conducted Emissions Limits

Test Requirement(s):

15.107 (a) Except for Class A digital devices, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in Table 7. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals.

15.107 (b) For a Class A digital device that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in Table 7. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals. The lower limit applies at the band edges.

Frequency range (MHz)	Class A Conducted Limits (dBµV)		*Class B Conducted Limits (dBµV)	
	Quasi-Peak	Average	Quasi-Peak	Average
* 0.15- 0.45	79	66	66 - 56	56 - 46
0.45 - 0.5	79	66	56	46
0.5 - 30	73	60	60	50
Note 1 — The lower limit shall apply at the transition frequencies. Note 2 — The limit decreases linearly with the logarithm if the frequency in the range 0.15 MHz to 0.5 MHz.				

Table 7. Conducted Limits for Radio Frequency Devices calculated from FCC Part 15 Subsections 15.107(a) (b)

Test Procedures:

The EUT plugged into a laptop and was placed on a non-metallic table, 80 cm above the ground plane inside a semi-anechoic chamber. The method of testing, test conditions, and test procedures of ANSI C63.4 were used. The EUT was powered through a 50Ω/50µH LISN. An EMI receiver, connected to the measurement port of the LISN, scanned the frequency range from 150 kHz to 30 MHz in order to find the peak conducted emissions. All peak emissions within 6 dB of the limit were re-measured using a quasi-peak and/or average detector as appropriate.

Test Results:

The EUT was compliant with the Class B requirement(s) of this section. Measured emissions were below applicable limits.

Test Engineer(s):

Anderson Soungpanya

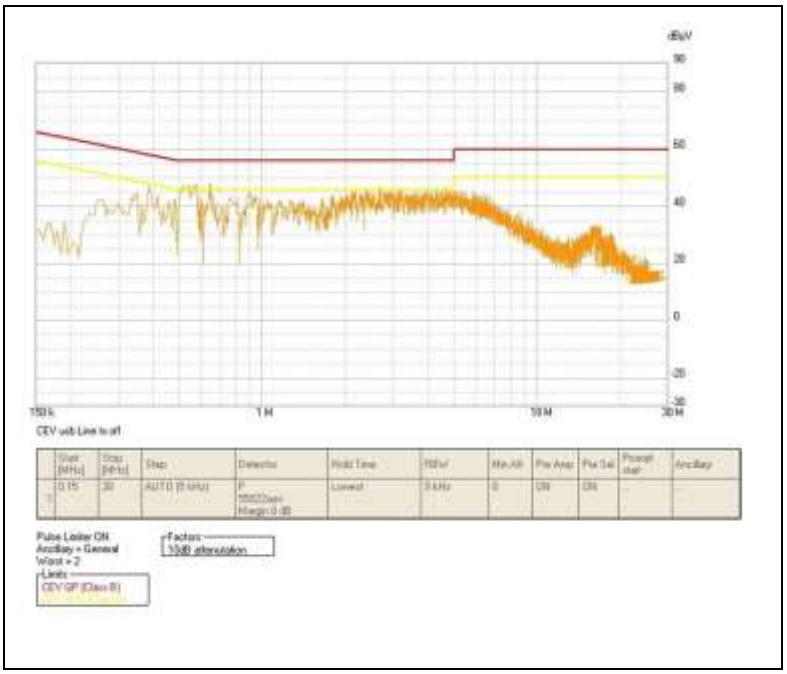
Test Date(s):

05/29/12

Conducted Emissions - Voltage, AC Power, Phase Line (120 VAC 60Hz)

Line	Freq. (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Line	.54	42.75	56	-13.25	Pass	28.16	46	-17.84	Pass
Line	.58	33.55	56	-22.45	Pass	13.38	46	-32.62	Pass
Line	.645	48.87	56	-7.13	Pass	30.63	46	-15.37	Pass
Line	.655	33.7	56	-22.3	Pass	17.45	46	-28.55	Pass
Line	2.685	41.17	56	-14.83	Pass	28.91	46	-17.09	Pass
Line	4.65	29.73	56	-26.27	Pass	20.67	46	-25.33	Pass

Table 8. Conducted Emissions - Voltage, AC Power, Phase Line (120 VAC 60Hz)

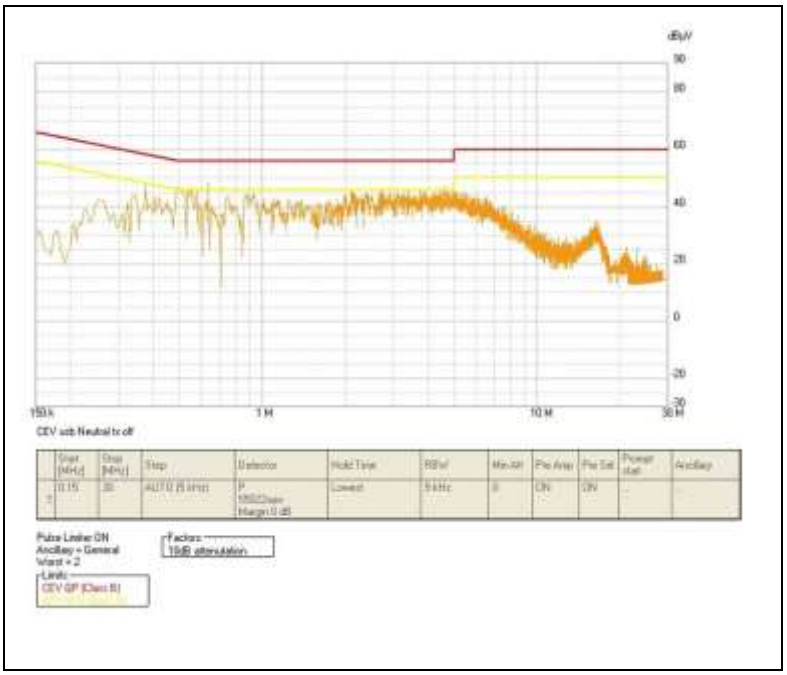


Plot 1. Conducted Emissions, Phase Line Plot

Conducted Emissions - Voltage, AC Power, Neutral Line (120VAC 60Hz)

Line	Freq. (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Neutral	.375	39.61	58.41	-18.8	Pass	30.66	48.41	-17.75	Pass
Neutral	.495	33.89	56.086	-22.196	Pass	23.97	46.086	-22.116	Pass
Neutral	.55	42.18	56	-13.82	Pass	23.1	46	-22.9	Pass
Neutral	.635	33.68	56	-22.32	Pass	20.73	46	-25.27	Pass
Neutral	2.69	41.34	56	-14.66	Pass	28	46	-18	Pass
Neutral	4.59	29.92	56	-26.08	Pass	21.67	46	-24.33	Pass

Table 9. Conducted Emissions - Voltage, AC Power, Neutral Line (120VAC 60Hz)



Plot 2. Conducted Emissions, Neutral Line Plot

Conducted Emission Limits Test Setup

Photograph 2. Conducted Emissions, Test Setup

Radiated Emission Limits

§ 15.109 Radiated Emissions Limits

Test Requirement(s): **15.109 (a)** Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the Class B limits expressed in Table 10.

15.109 (b) The field strength of radiated emissions from a Class A digital device, as determined at a distance of 10 meters, shall not exceed the Class A limits expressed in Table 10.

Frequency (MHz)	Field Strength (dBµV/m)	
	§15.109 (b), Class A Limit (dBµV) @ 10m	§15.109 (a),Class B Limit (dBµV) @ 3m
30 - 88	39.00	40.00
88 - 216	43.50	43.50
216 - 960	46.40	46.00
Above 960	49.50	54.00

Table 10. Radiated Emissions Limits calculated from FCC Part 15, §15.109 (a) (b)

Test Procedures: The EUT plugged into a laptop and was placed on a non-metallic table, 80 cm above the ground plane inside a semi-anechoic chamber. The method of testing and test conditions of ANSI C63.4 were used. An antenna was located 10 m from the EUT on an adjustable mast. A pre-scan was first performed in order to find prominent radiated emissions. For final emissions measurements at each frequency of interest, the EUT was rotated and the antenna height was varied between 1 m and 4 m in order to maximize the emission. Measurements in both horizontal and vertical polarities were made and the data was recorded. Unless otherwise specified, measurements were made using a quasi-peak detector with a 120 kHz bandwidth.

Test Results: The EUT was compliant with the Class B requirement(s) of this section. Measured emissions were below applicable limits.

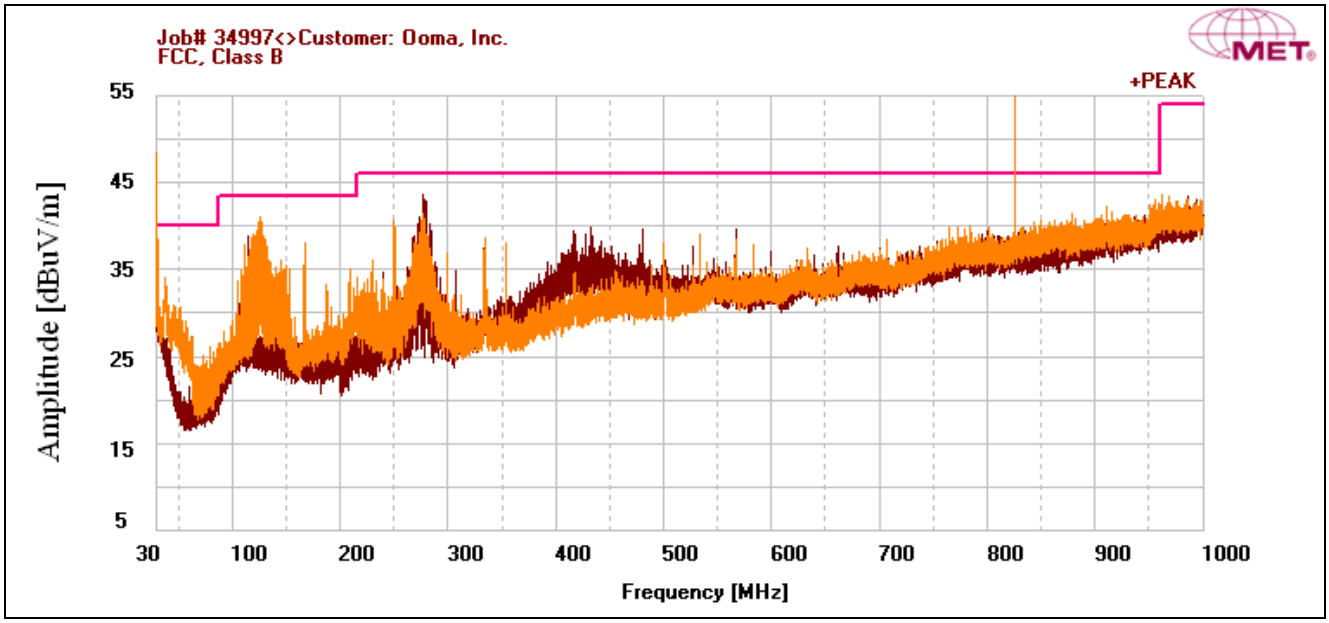
Test Engineer(s): Hanbo Tao

Test Date(s): 05/22/12

Radiated Emissions Limits Test Results, Class B

Frequency (MHz)	Antenna Polarity	EUT Azimuth (Degrees)	Antenna Height (cm)	Uncorrected Amplitude (dBuV)	ACF (dB/m)	Pre Amp Gain (dB)	CBL (dB)	DCF (dB)	Corrected Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
35.96	V	79	100	31.856	13.724	30.463	0	10.46	25.577	40	-14.423
276.795	H	360	245	41.148	13.128	28.166	0	10.46	36.57	46	-9.43
109.947	H	209	400	38.309	11.895	29.533	0	10.46	31.131	43.5	-12.369
125.769	V	360	100	43.175	12.177	29.377	0	10.46	36.435	43.5	-7.065
278.31	V	241	100	38.44	13.468	28.157	0	10.46	34.211	46	-11.789
167.35	V	196	100	39.36	9.835	28.97	0	10.46	30.685	43.5	-12.815

Table 11. Radiated Emissions Limits, Test Results, 30 MHz – 1 GHz, FCC Limits



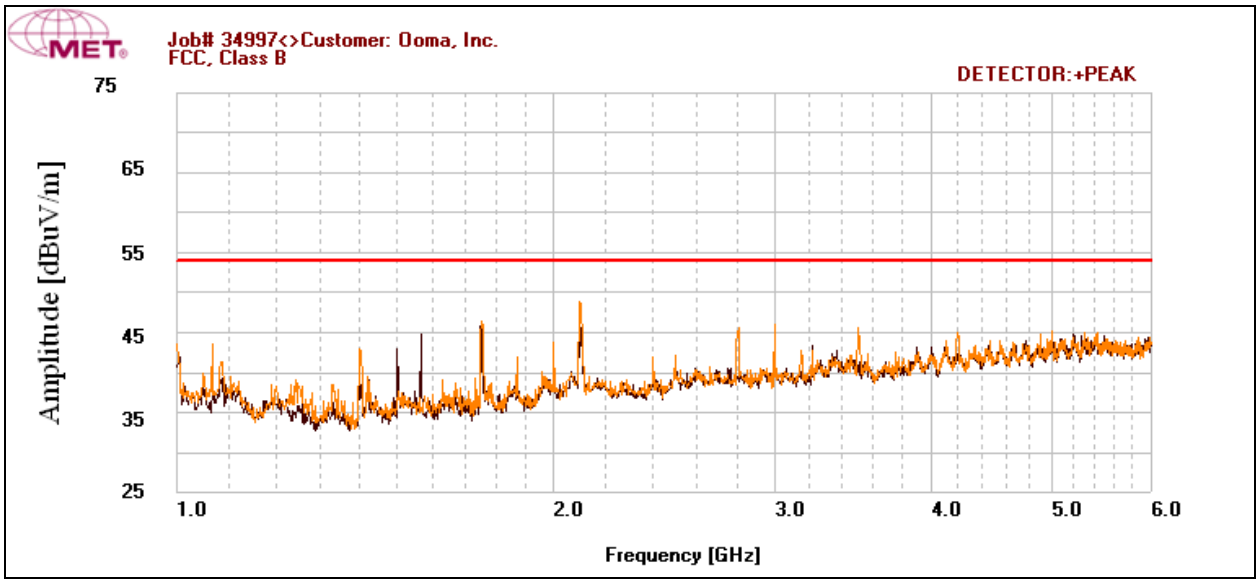
Plot 3. Radiated Emissions, 30 MHz - 1 GHz, FCC Limits

825 MHz was investigated and was spurious emission.

Radiated Emissions Limits Test Results, Class B

Frequency (MHz)	Antenna Polarity	EUT Azimuth (Degrees)	Antenna Height (cm)	Uncorrected Amplitude (dBuV)	ACF (dB/m)	Pre Amp Gain (dB)	CBL (dB)	DCF (dB)	Corrected Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2099	V	155	100	60.12	28.797	54.878	0	0	34.039	54	-19.961

Table 12. Radiated Emissions Limits, Test Results, 1 GHz – 6 GHz, FCC Limits

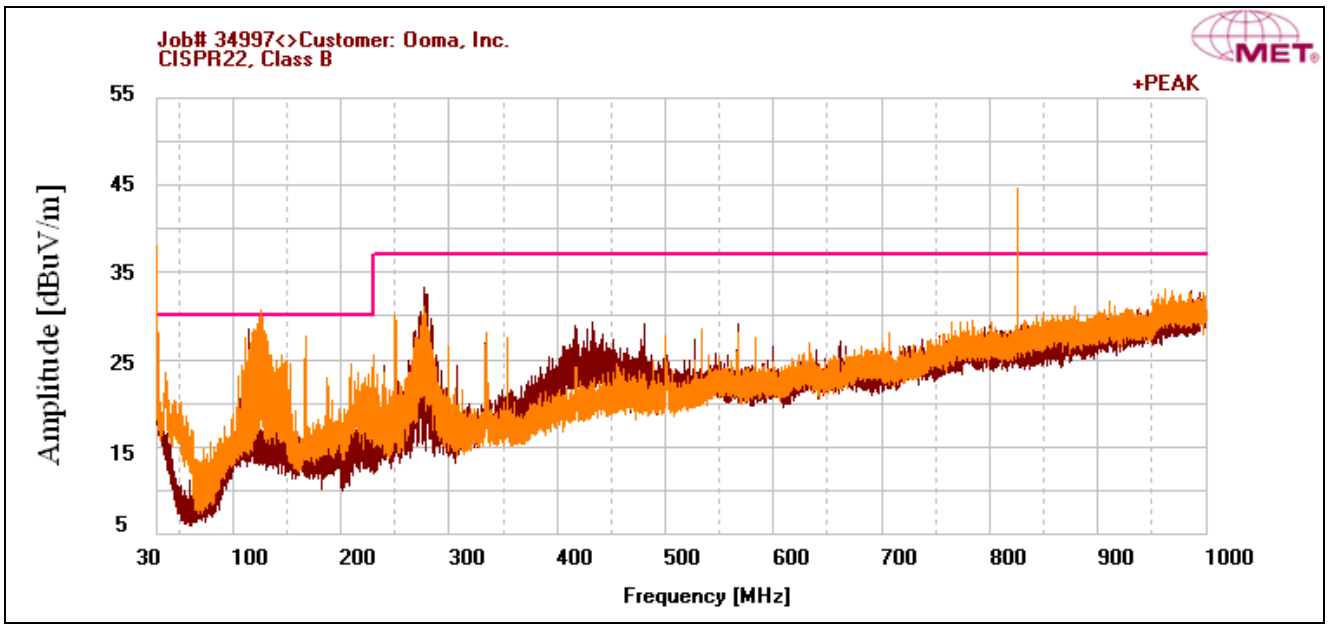


Plot 4. Radiated Emissions, 1 GHz – 6 GHz, FCC Limits

Radiated Emissions Limits Test Results, Class B

Frequency (MHz)	Antenna Polarity	EUT Azimuth (Degrees)	Antenna Height (cm)	Uncorrected Amplitude (dBuV)	ACF (dB/m)	Pre Amp Gain (dB)	CBL (dB)	DCF (dB)	Corrected Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
35.96	V	79	100	31.856	13.724	30.463	0	0	15.117	30	-14.883
109.947	H	209	400	38.309	11.895	29.533	0	0	20.671	30	-9.329
125.769	V	360	100	43.175	12.177	29.377	0	0	25.975	30	-4.025
167.35	V	196	100	39.36	9.835	28.97	0	0	20.225	30	-9.775
276.795	H	360	245	41.148	13.128	28.166	0	0	26.11	37	-10.89
278.31	V	241	100	38.44	13.468	28.157	0	0	23.751	37	-13.249

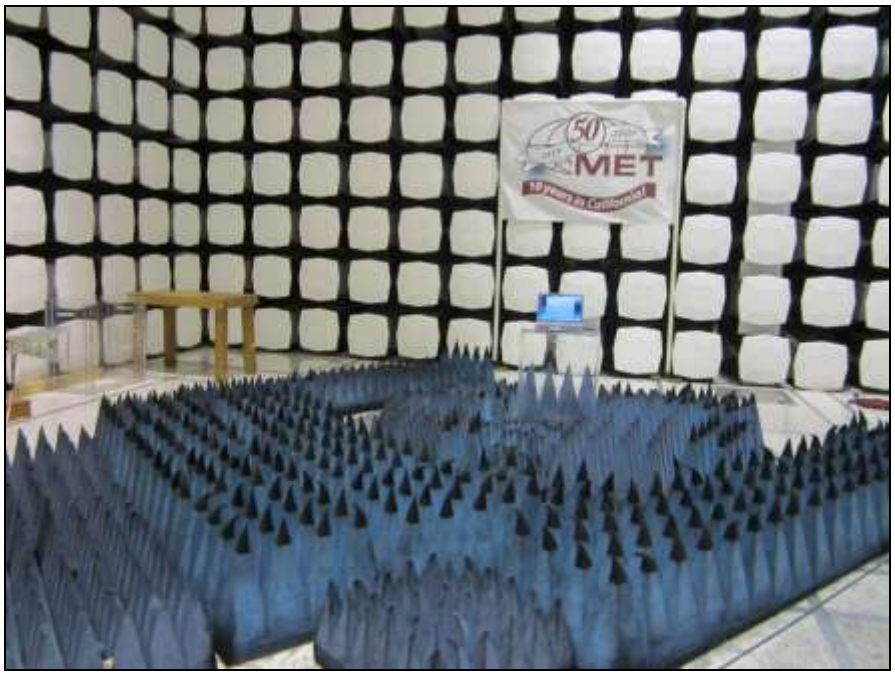
Table 13. Radiated Emissions Limits, Test Results, ICES-003 Limits



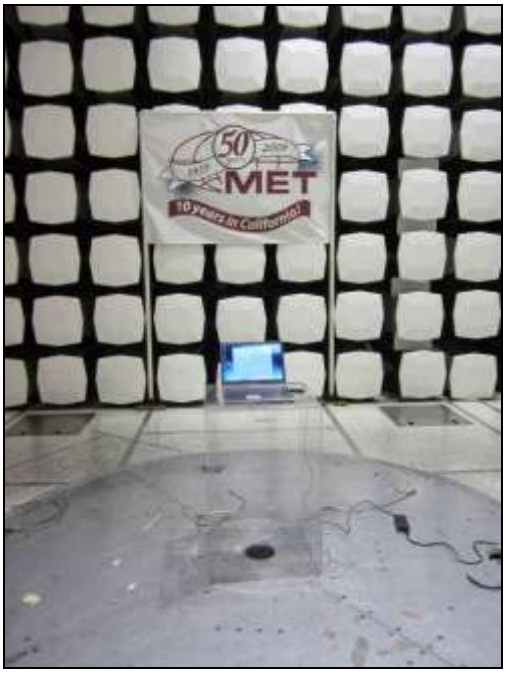
Plot 5. Radiated Emissions, ICES-003 Limits

Radiated Emission Limits Test Setup

Photograph 3. Radiated Emissions, Test Setup, 30 MHz – 1 GHz



Photograph 4. Radiated Emissions, Test Setup, 1 GHz – 6 GHz



Photograph 5. Radiated Emissions, Test Setup, Front View

Photograph 6. Radiated Emissions, Test Setup, Rear View

IV. Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.203 Antenna Requirement

Test Requirement: **§ 15.203:** An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

a.) Antenna must be permanently attached to the unit.

b.) Antenna must use a unique type of connector to attach to the EUT.

c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

Results: The EUT as tested is compliant the criteria of §15.203. The EUT has an integral PCB antenna.

Test Engineer(s): Anderson Soungpanya

Test Date(s): 05/14/12

Gain	Type	Model	Manufacturer
1.2 dBi	Integral PCB	NA	Ooma

Table 14. Antenna List

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.207(a) Conducted Emissions Limits

Test Requirement(s): **§ 15.207 (a):** For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency range (MHz)	§ 15.207(a), Conducted Limit (dBμV)	
	Quasi-Peak	Average
* 0.15- 0.45	66 - 56	56 - 46
0.45 - 0.5	56	46
0.5 - 30	60	50

Table 15. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)

Test Procedure: The EUT was placed on a 0.8 m-high wooden table inside a screen room. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50 Ω/50 μH Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with *ANSI C63.4-2003 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"*. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 μH LISN as the input transducer to an EMC/field intensity meter. For the purpose of this testing, the transmitter was turned on. Scans were performed with the transmitter on.

Test Results: The EUT was compliant with this requirement. Measured emissions were below applicable limits.

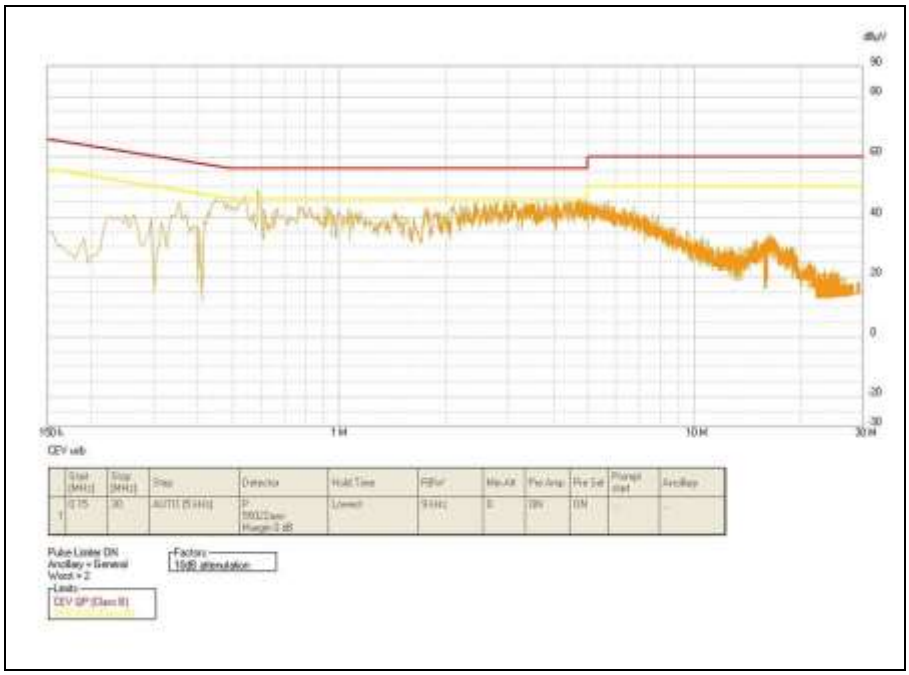
Test Engineer(s): Anderson Soungpanya

Test Date(s): 05/29/12

15.207(a) Conducted Emissions Test Results

Line	Freq. (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Line	.54	44.26	56	-11.74	Pass	27.96	46	-18.04	Pass
Line	.59	27.69	56	-28.31	Pass	19.58	46	-26.42	Pass
Line	3.815	38.21	56	-17.79	Pass	28.46	46	-17.54	Pass
Line	4.085	28.7	56	-27.3	Pass	20.1	46	-25.9	Pass
Line	4.76	40.26	56	-15.74	Pass	32.71	46	-13.29	Pass
Line	5.725	28.05	60	-31.95	Pass	21.02	50	-28.98	Pass

Table 16. Conducted Emissions, 15.207(a), Phase Line, Test Results

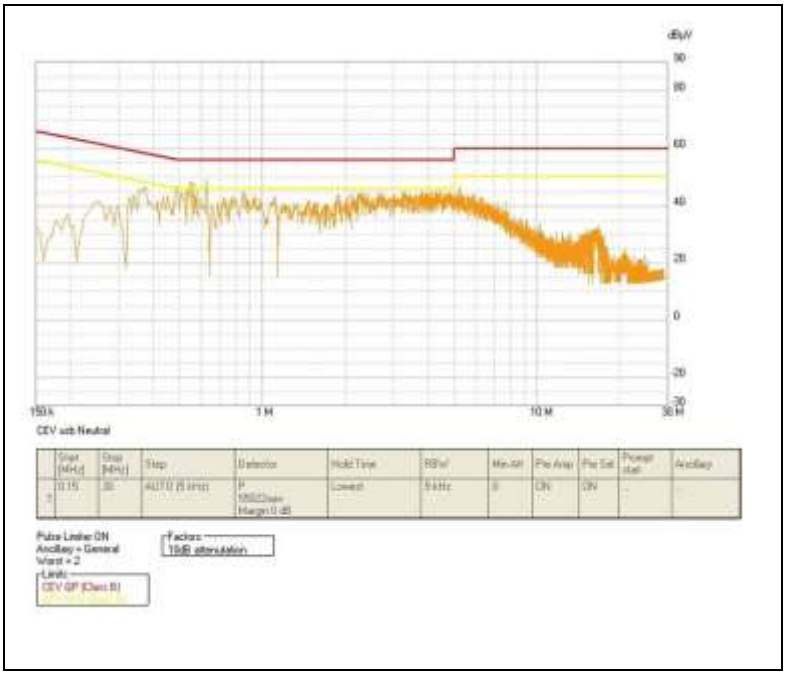


Plot 6. Conducted Emissions, 15.207(a), Phase Line

15.207(a) Conducted Emissions Test Results

Line	Freq. (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Neutral	.375	43.13	58.41	-15.28	Pass	28.52	48.41	-19.89	Pass
Neutral	.49	34.36	56.173	-21.813	Pass	26.09	46.173	-20.083	Pass
Neutral	.545	43.04	56	-12.96	Pass	26.57	46	-19.43	Pass
Neutral	.565	33.76	56	-22.24	Pass	10.52	46	-35.48	Pass
Neutral	.625	44.11	56	-11.89	Pass	29.32	46	-16.68	Pass
Neutral	5.255	29.2	60	-30.8	Pass	21.04	50	-28.96	Pass

Table 17. Conducted Emissions, 15.207(a), Neutral Line, Test Results



Plot 7. Conducted Emissions, 15.207(a), Neutral Line

15.207(a) Conducted Emissions Test Setup Photo

Photograph 7. Conducted Emissions, 15.207(a), Test Setup

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(2) 6 dB and 99% Bandwidth

Test Requirements: **§ 15.247(a)(2):** Operation under the provisions of this section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

For systems using digital modulation techniques, the EUT may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands. The minimum 6dB bandwidth shall be at least 500 kHz.

Test Procedure: The transmitter was on and transmitting at the highest output power. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately 1% of the total emission bandwidth, VBW > RBW. The 6 dB Bandwidth was measured and recorded. The measurements were performed on the low, mid and high channels.

Test Results The EUT was compliant with § 15.247 (a)(2).

The 6 dB and 99% Bandwidth was determined from the plots on the following pages.

Test Engineer(s): Anderson Soungpanya

Test Date(s): 05/14/12

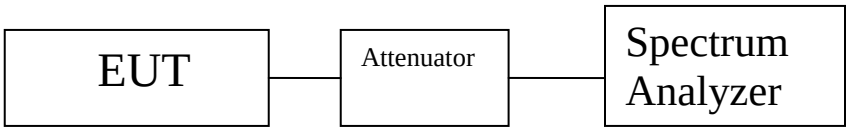


Figure 2. Block Diagram, Occupied Bandwidth Test Setup

Occupied Bandwidth Test Results

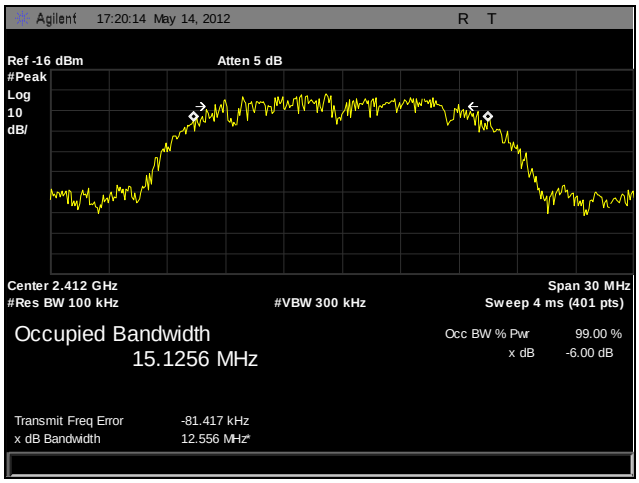
Occupied Bandwidth			
Mode	**Carrier Channel**	**Frequency (MHz)**	**Measured 6 dB Bandwidth (MHz)**
802.11b	Low	2412	12.556
	Mid	2437	12.763
	High	2462	12.803
802.11g	Low	2412	16.384
	Mid	2437	16.315
	High	2462	16.341
802.11n 20 MHz	Low	2412	17.387
	Mid	2437	17.386
	High	2462	17.499
802.11n 40 MHz	Low	2422	36.045
	Mid	2437	36.008
	High	2452	35.050

Table 18. 6 dB Occupied Bandwidth, Test Results

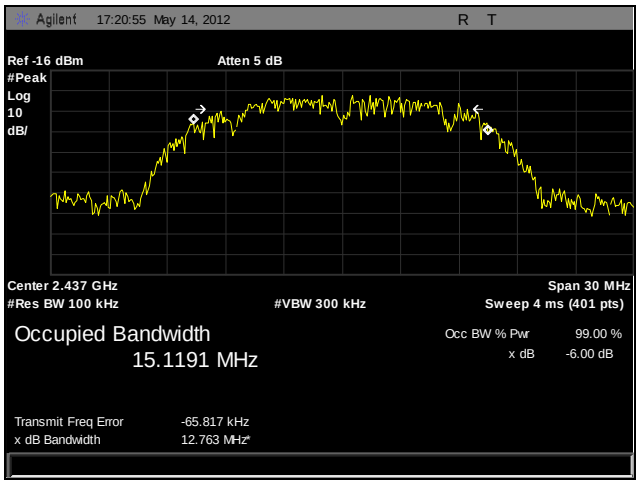
Occupied Bandwidth			
Mode	**Carrier Channel**	**Frequency (MHz)**	**Measured 99% Bandwidth (MHz)**
802.11b	Low	2412	14.7253
	Mid	2437	14.8886
	High	2462	14.8462
802.11g	Low	2412	16.3384
	Mid	2437	16.4575
	High	2462	16.3819
802.11n 20 MHz	Low	2412	17.4252
	Mid	2437	17.4934
	High	2462	17.4804
802.11n 40 MHz	Low	2422	36.3900
	Mid	2437	36.4920
	High	2452	36.1712

Table 19. 99% Occupied Bandwidth, Test Results

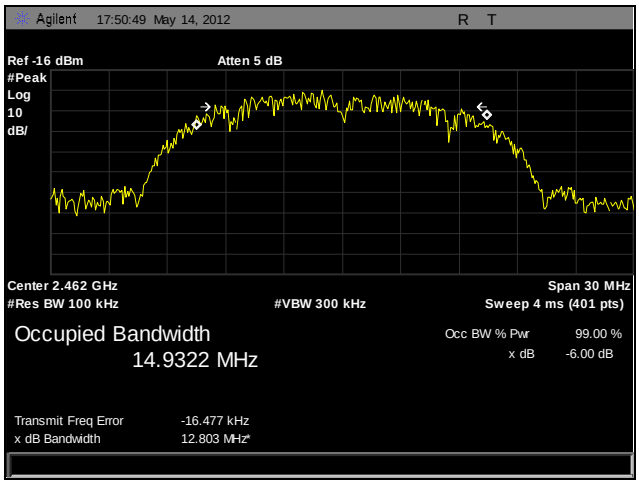
6 dB Occupied Bandwidth Test Results, 802.11b



Plot 8. 6 dB Occupied Bandwidth, Low Channel, 802.11b

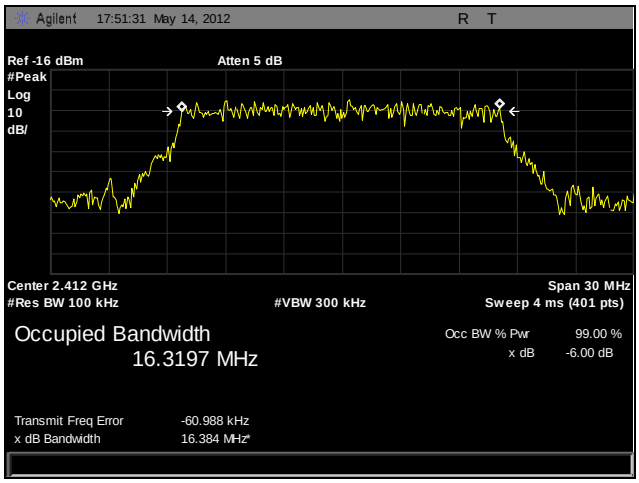


Plot 9. 6 dB Occupied Bandwidth, Mid Channel, 802.11b

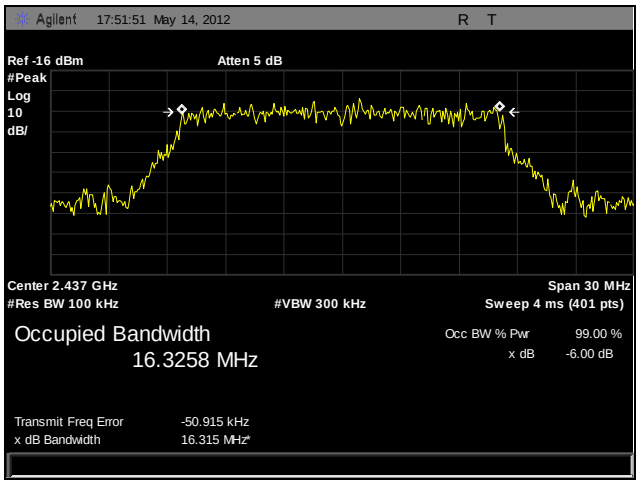


Plot 10. 6 dB Occupied Bandwidth, High Channel, 802.11b

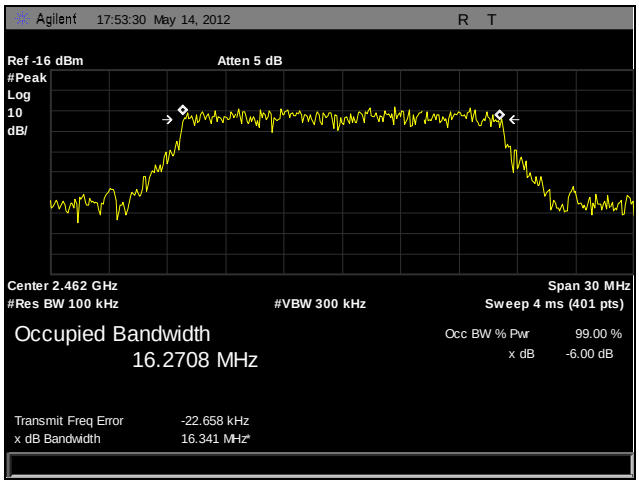
6 dB Occupied Bandwidth Test Results, 802.11g



Plot 11. 6 dB Occupied Bandwidth, Low Channel, 802.11g

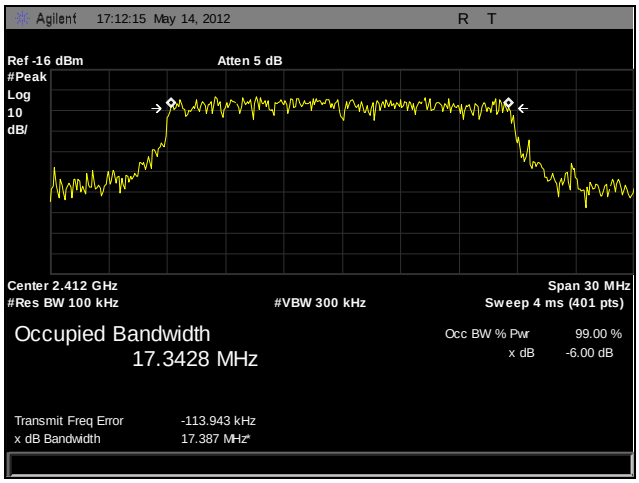


Plot 12. 6 dB Occupied Bandwidth, Mid Channel, 802.11g

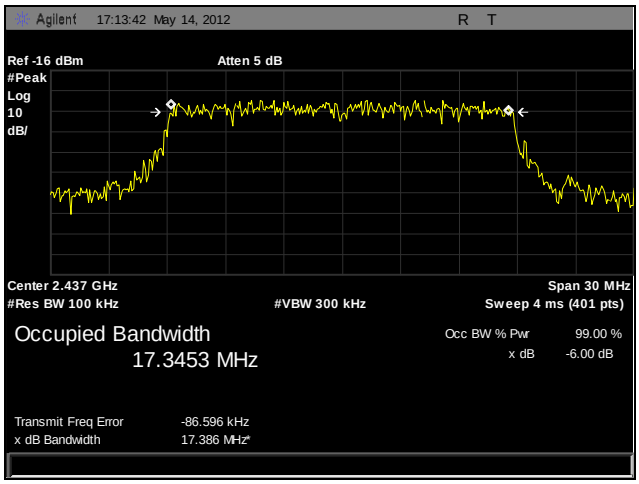


Plot 13. 6 dB Occupied Bandwidth, High Channel, 802.11g

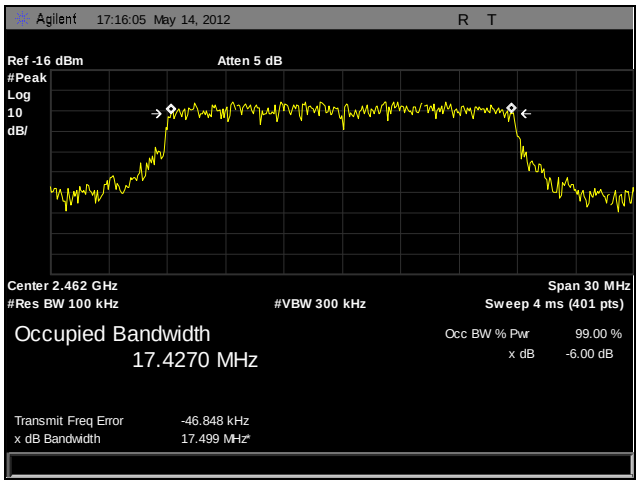
6 dB Occupied Bandwidth Test Results, 802.11n 20 MHz



Plot 14. 6 dB Occupied Bandwidth, Low Channel, 802.11n 20 MHz

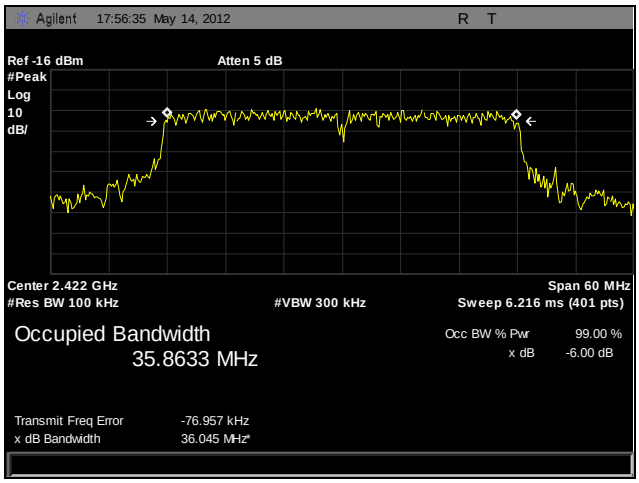


Plot 15. 6 dB Occupied Bandwidth, Mid Channel, 802.11n 20 MHz

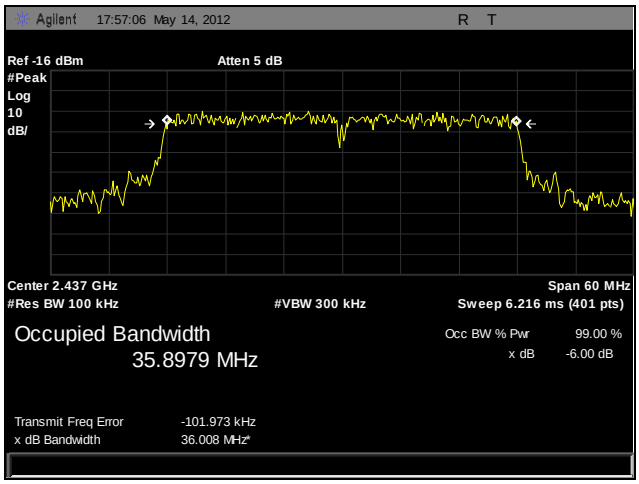


Plot 16. 6 dB Occupied Bandwidth, High Channel, 802.11n 20 MHz

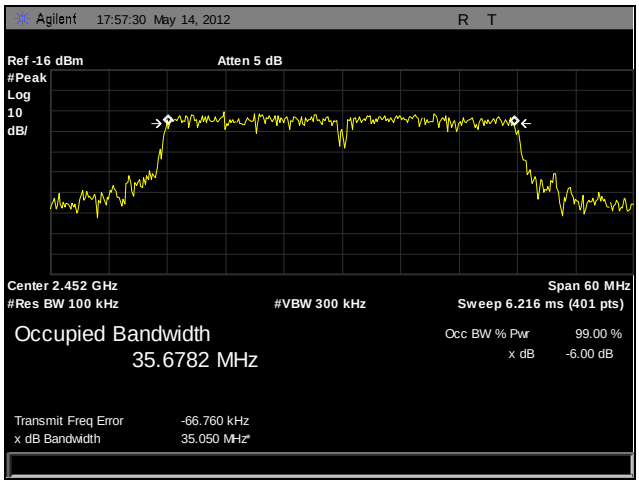
6 dB Occupied Bandwidth Test Results, 802.11n 40 MHz



Plot 17. 6 dB Occupied Bandwidth, Low Channel, 802.11n 40 MHz

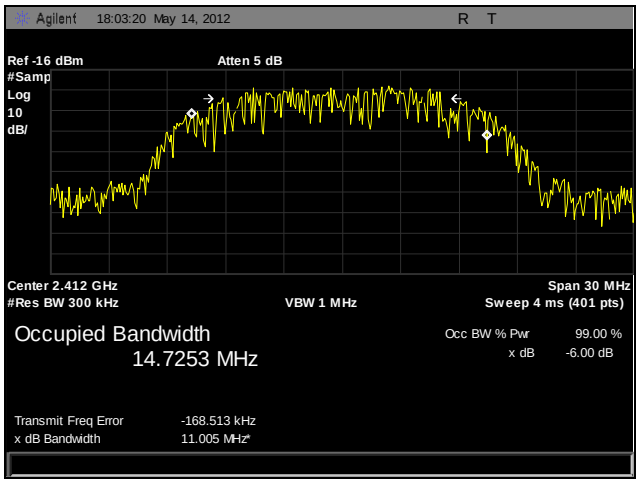


Plot 18. 6 dB Occupied Bandwidth, Mid Channel, 802.11n 40 MHz

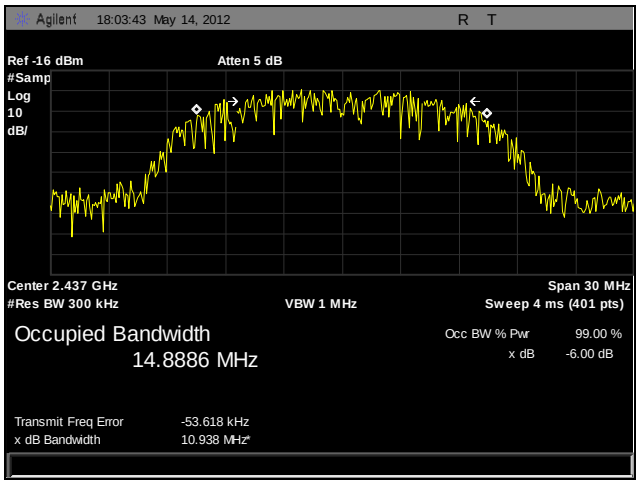


Plot 19. 6 dB Occupied Bandwidth, High Channel, 802.11n 40 MHz

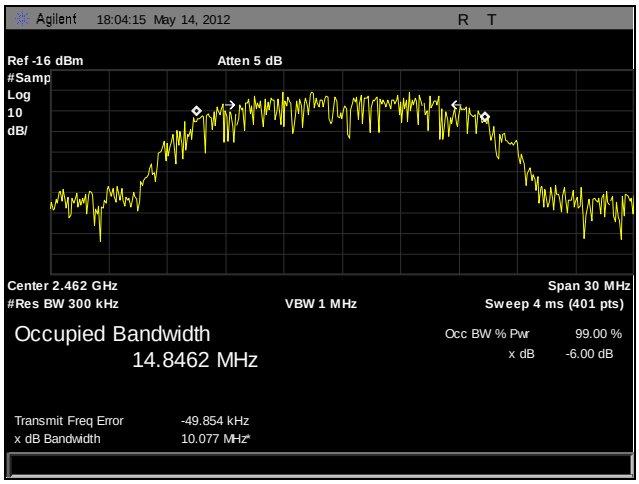
99% Occupied Bandwidth Test Results, 802.11b



Plot 20. 99% Occupied Bandwidth, Low Channel, 802.11b

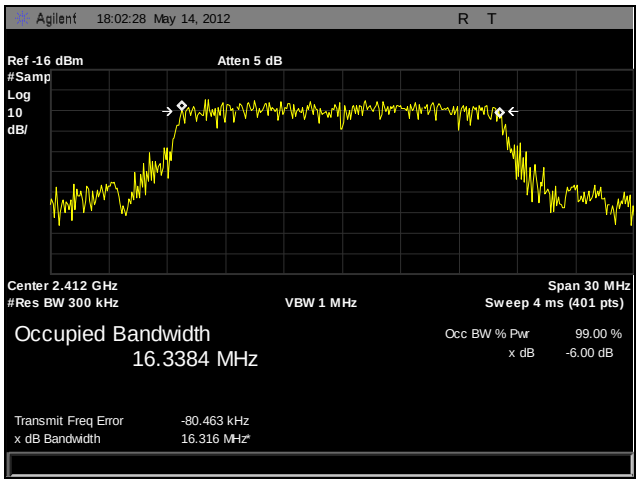


Plot 21. 99% Occupied Bandwidth, Mid Channel, 802.11b

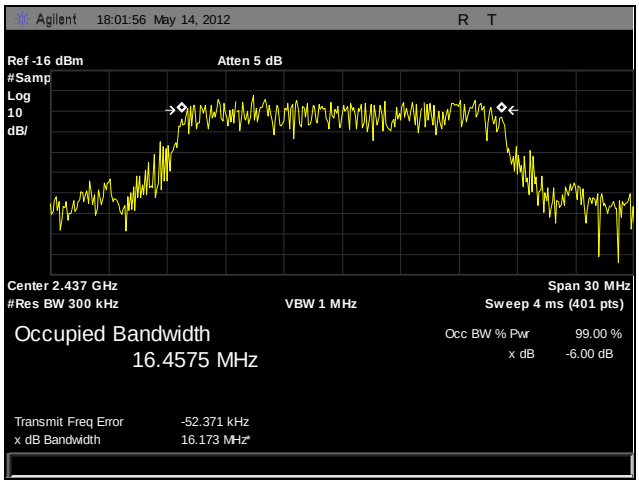


Plot 22. 99% Occupied Bandwidth, High Channel, 802.11b

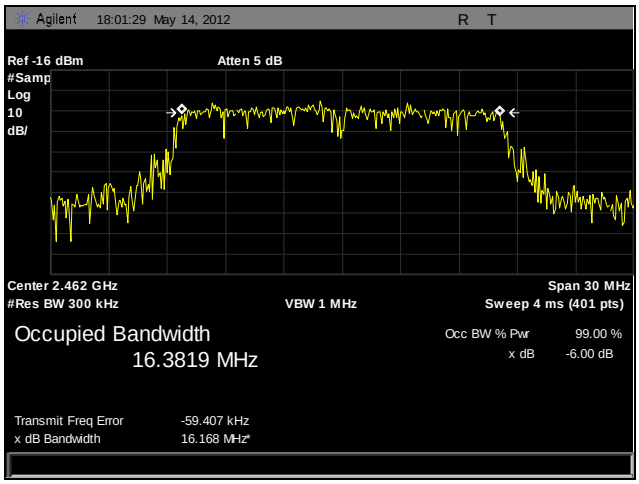
99% Occupied Bandwidth Test Results, 802.11g



Plot 23. 99% Occupied Bandwidth, Low Channel, 802.11g

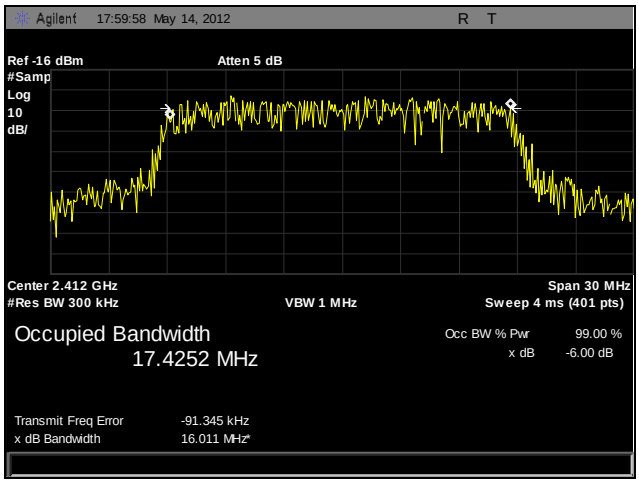


Plot 24. 99% Occupied Bandwidth, Mid Channel, 802.11g

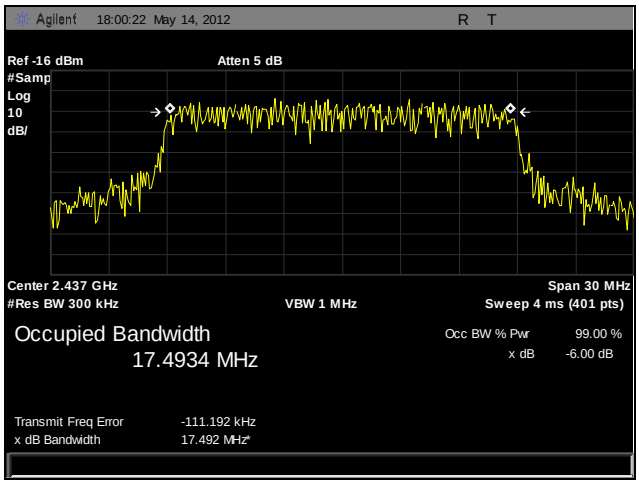


Plot 25. 99% Occupied Bandwidth, High Channel, 802.11g

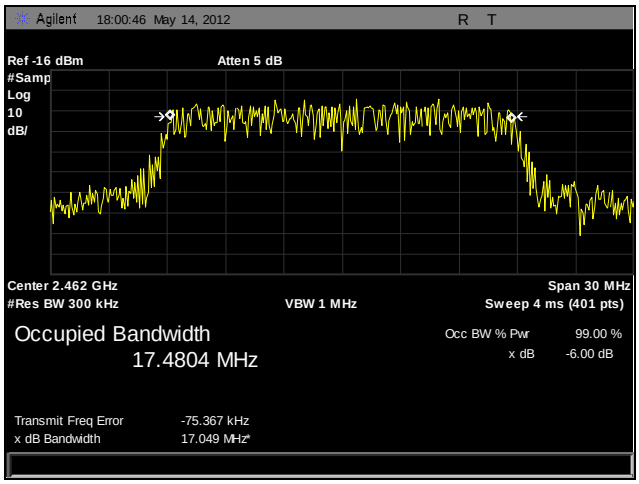
99% Occupied Bandwidth Test Results, 802.11n 20 MHz



Plot 26. 99% Occupied Bandwidth, Low Channel, 802.11n 20 MHz

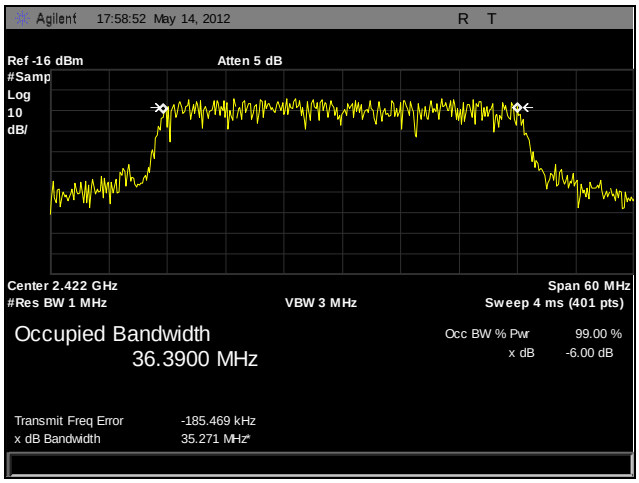


Plot 27. 99% Occupied Bandwidth, Mid Channel, 802.11n 20 MHz

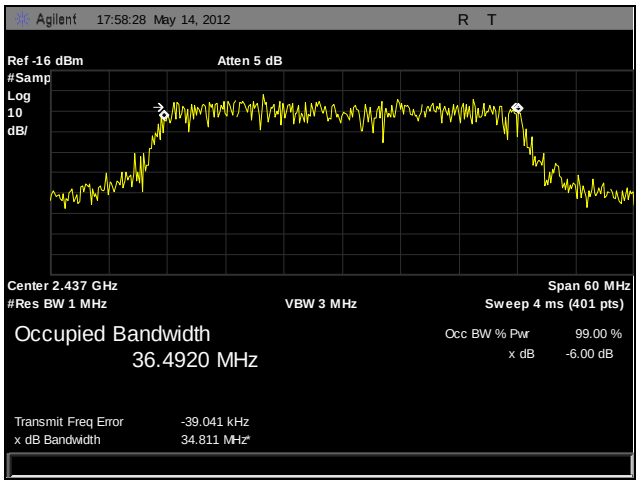


Plot 28. 99% Occupied Bandwidth, High Channel, 802.11n 20 MHz

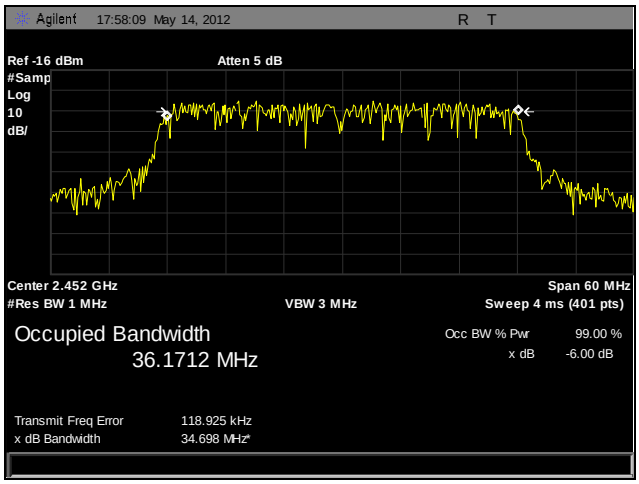
99% Occupied Bandwidth Test Results, 802.11n 40 MHz



Plot 29. 99% Occupied Bandwidth, Low Channel, 802.11n 40 MHz



Plot 30. 99% Occupied Bandwidth, Mid Channel, 802.11n 40 MHz



Plot 31. 99% Occupied Bandwidth, High Channel, 802.11n 40 MHz

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) Peak Power Output

Test Requirements: **§15.247(b):** The maximum peak output power of the intentional radiator shall not exceed the following:

Digital Transmission Systems (MHz)	Output Limit (Watts)
902-928	1.000
2400–2483.5	1.000
5725– 5850	1.000

Table 20. Output Power Requirements from §15.247(b)

§15.247(c): if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values in the Table 20, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 2400 – 2483.5 MHz band and using a point to point application may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 5725 – 5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

Fixed, point-to-point operation excludes the use of point-to-multipoint systems, Omni-directional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

Test Procedure: The transmitter was connected to a calibrated spectrum analyzer. The EUT was measured at the low, mid and high channels of each band at the maximum power level.

Test Results: The EUT was compliant with the Peak Power Output limits of **§15.247(b)**.

Test Engineer(s): Anderson Soungpanya

Test Date(s): 05/30/12

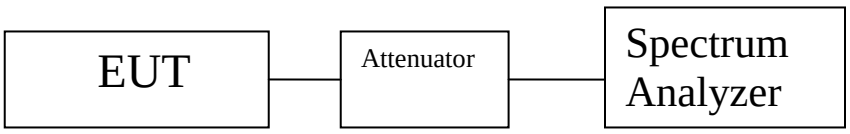


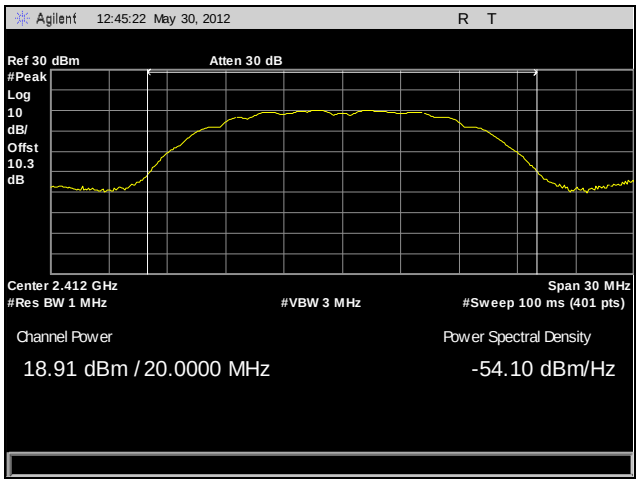
Figure 3. Peak Power Output Test Setup

Peak Power Output Test Results

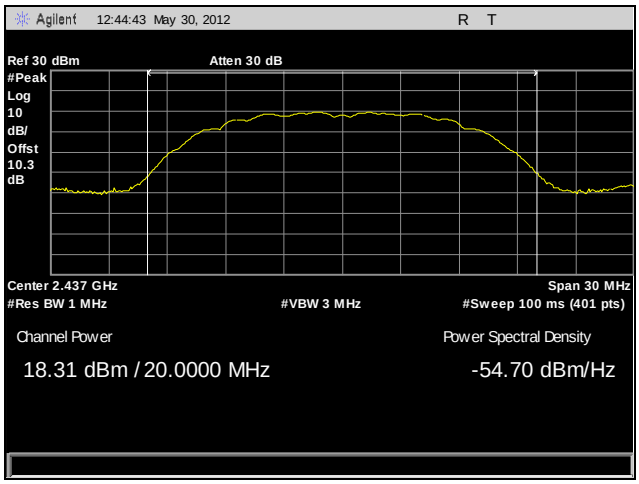
Peak Power Output			
Mode	**Carrier Channel**	**Frequency (MHz)**	**Peak Power Output (dBm)**
802.11b	Low	2412	18.91
	Mid	2437	18.31
	High	2462	17.12
802.11g	Low	2412	24.93
	Mid	2437	24.61
	High	2462	23.77
802.11n 20 MHz	Low	2412	24.84
	Mid	2437	24.67
	High	2462	24.07
802.11n 40 MHz	Low	2422	24.89
	Mid	2437	24.80
	High	2452	24.43

Table 21. Peak Power Output, Test Results

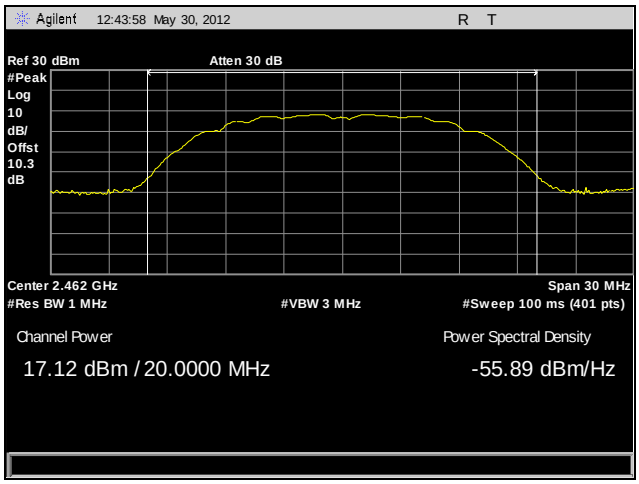
Peak Power Output Test Results, 802.11b



Plot 32. Peak Power Output, Low Channel, 802.11b

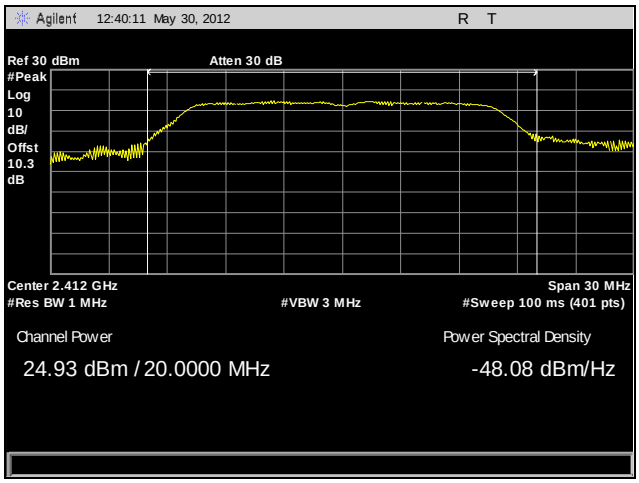


Plot 33. Peak Power Output, Mid Channel, 802.11b

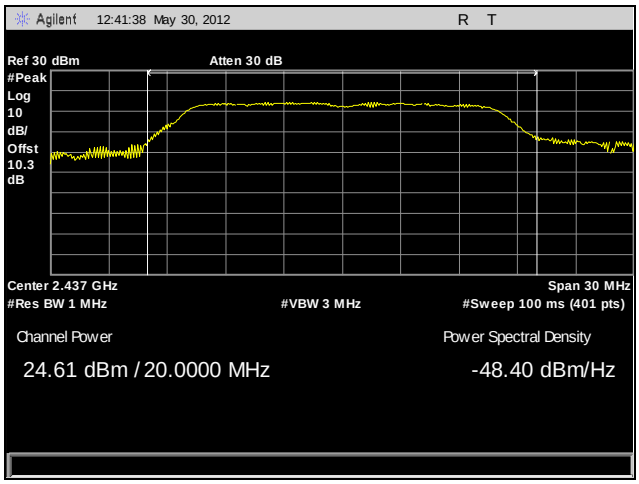


Plot 34. Peak Power Output, High Channel, 802.11b

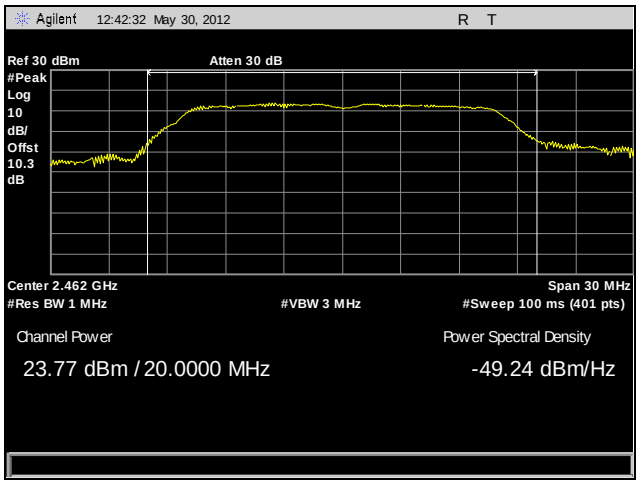
Peak Power Output Test Results, 802.11g



Plot 35. Peak Power Output, Low Channel, 802.11g

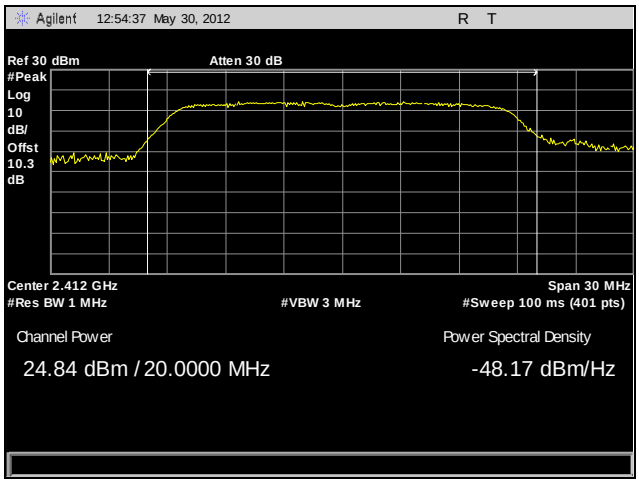


Plot 36. Peak Power Output, Mid Channel, 802.11g

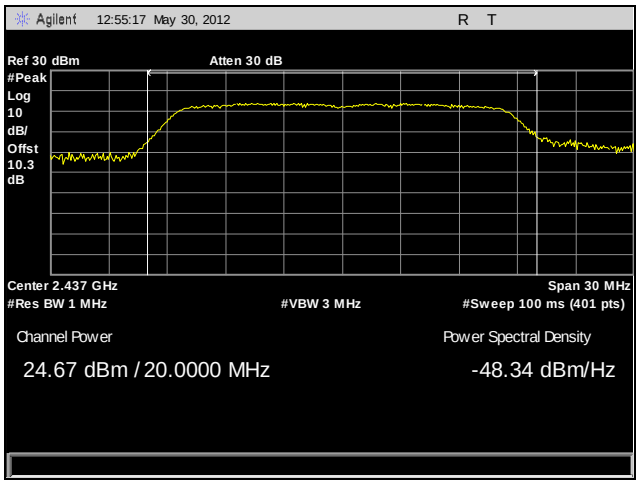


Plot 37. Peak Power Output, High Channel, 802.11g

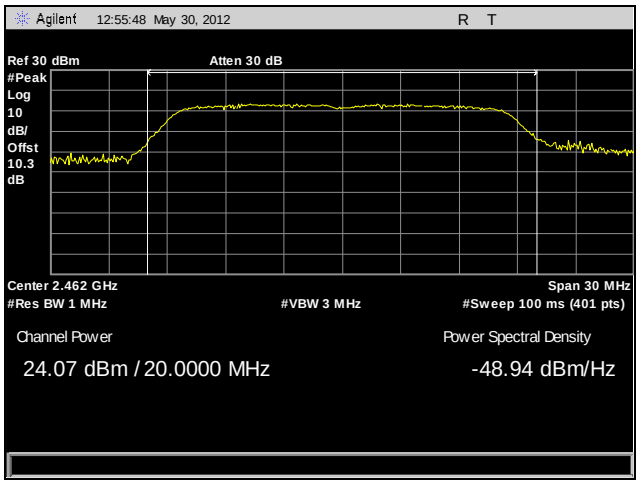
Peak Power Output Test Results, 802.11n 20 MHz



Plot 38. Peak Power Output, Low Channel, 802.11n 20 MHz

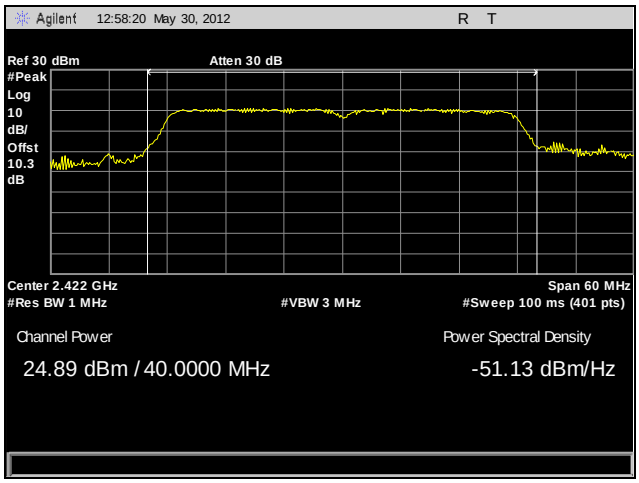


Plot 39. Peak Power Output, Mid Channel, 802.11n 20 MHz

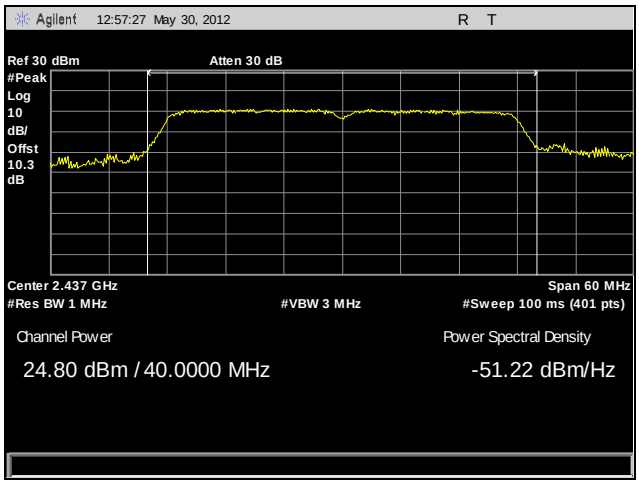


Plot 40. Peak Power Output, High Channel, 802.11n 20 MHz

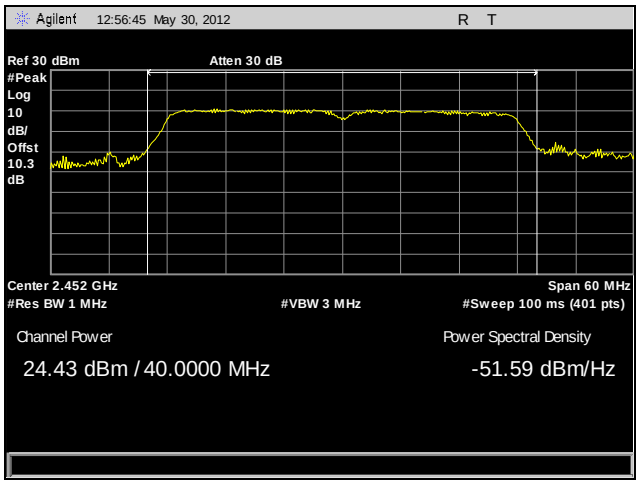
Peak Power Output Test Results, 802.11n 40 MHz



Plot 41. Peak Power Output, Low Channel, 802.11n 40 MHz



Plot 42. Peak Power Output, Mid Channel, 802.11n 40 MHz



Plot 43. Peak Power Output, High Channel, 802.11n 40 MHz

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) Radiated Spurious Emissions Requirements and Band Edge

Test Requirements: **§15.247(d); §15.205:** Emissions outside the frequency band.

§15.247(d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a).

§15.205(a): Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090–0.110----------	16.42–16.423	399.9–410	4.5–5.15
[1] 0.495–0.505----------	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905----------	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128----------	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775----------	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775----------	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218----------	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825----------	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225----------	123–138	2200–2300	14.47–14.5
8.291–8.294----------	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366----------	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675----------	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475----------	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293----------	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025----------	240–285	3345.8–3358 36.	43–36.5
12.57675–12.57725----------	322–335.4	3600–4400	([2])

Table 22. Restricted Bands of Operation

[1] Until February 1, 1999, this restricted band shall be 0.490 – 0.510 MHz.
[2] Above 38.6

Test Requirement(s): **§ 15.209 (a):** Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in Table 23.

Frequency (MHz)	§ 15.209(a),Radiated Emission Limits (dBµV) @ 3m
30 - 88	40.00
88 - 216	43.50
216 - 960	46.00
Above 960	54.00

Table 23. Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)

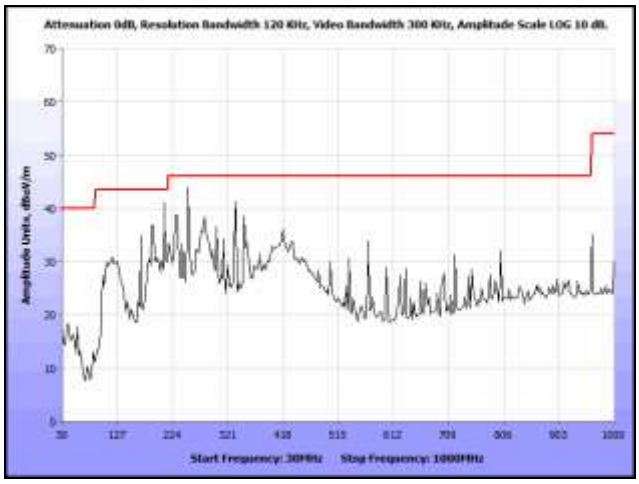
Test Procedures: The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor, cable loss, preamp and distance and compared to a 3 m limit line. Only noise floor was measured above 18 GHz.

Test Results: The EUT was compliant with the Radiated Spurious Emission limits of **§ 15.247(d)**.

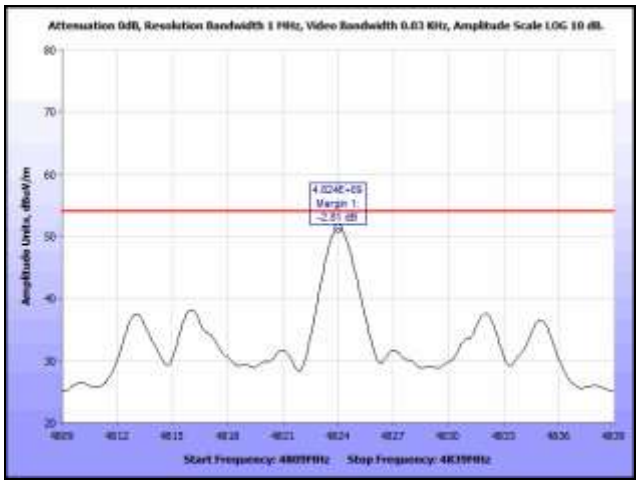
Test Engineer(s): Anderson Soungpanya

Test Date(s): 05/23/12

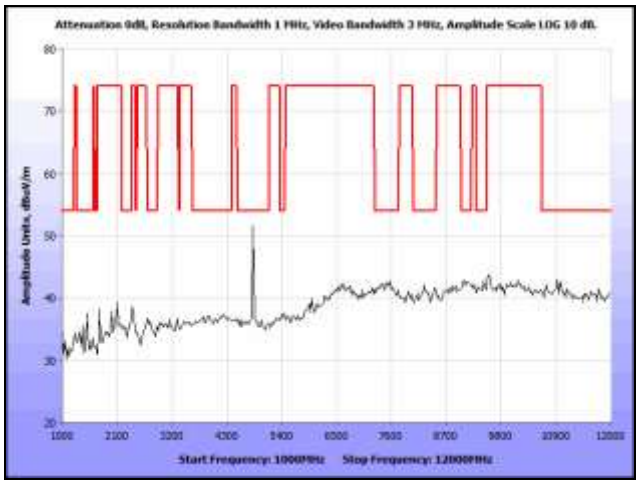
Radiated Spurious Emissions Test Results, 802.11b



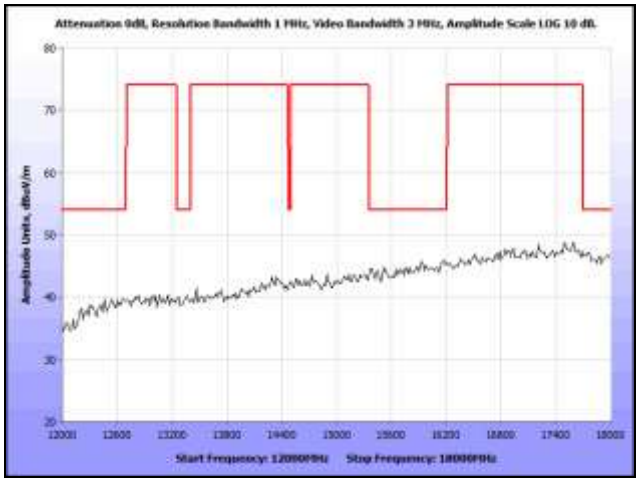
Plot 44. Radiated Spurious Emissions, Low Channel, 802.11b, 30 MHz – 1 GHz



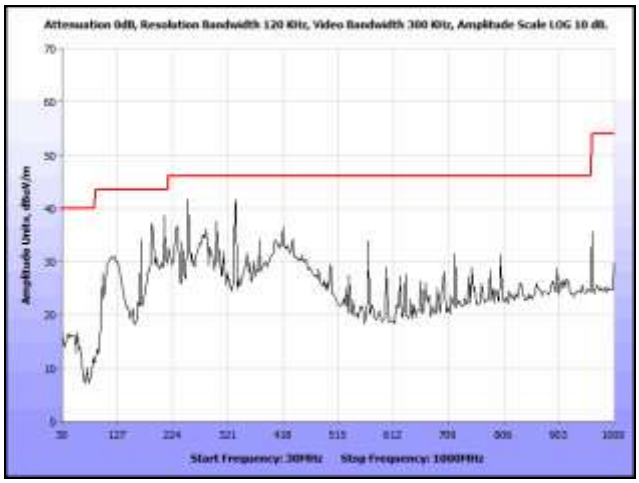
Plot 45. Radiated Spurious Emissions, Low Channel, 802.11b, 1 GHz – 12 GHz (Zoomed 4.824 GHz)



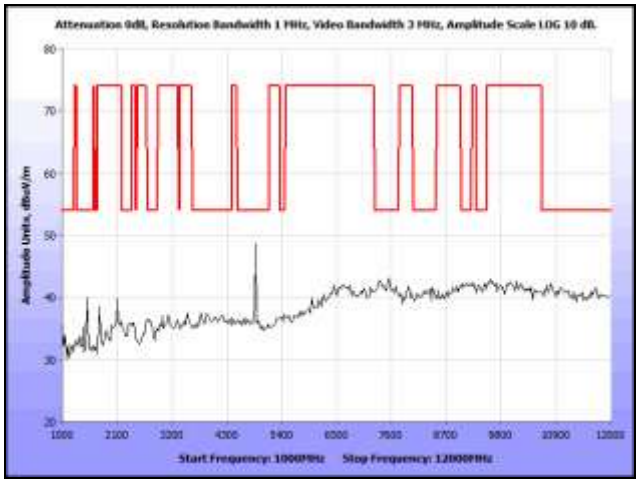
Plot 46. Radiated Spurious Emissions, Low Channel, 802.11b, 1 GHz – 12 GHz



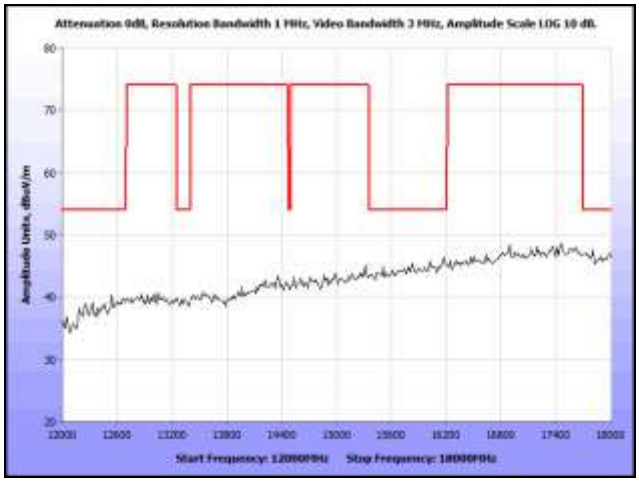
Plot 47. Radiated Spurious Emissions, Low Channel, 802.11b, 12 GHz – 18 GHz



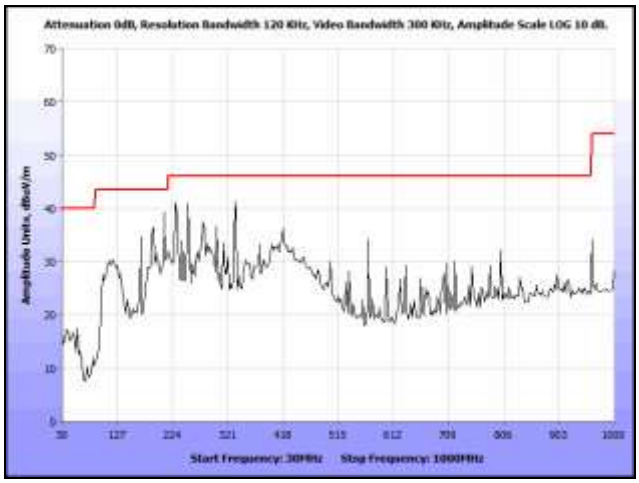
Plot 48. Radiated Spurious Emissions, Mid Channel, 802.11b, 30 MHz – 1 GHz



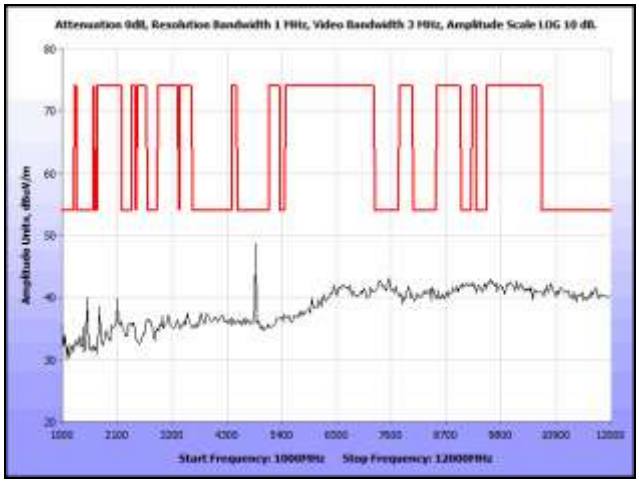
Plot 49. Radiated Spurious Emissions, Mid Channel, 802.11b, 1 GHz – 12 GHz



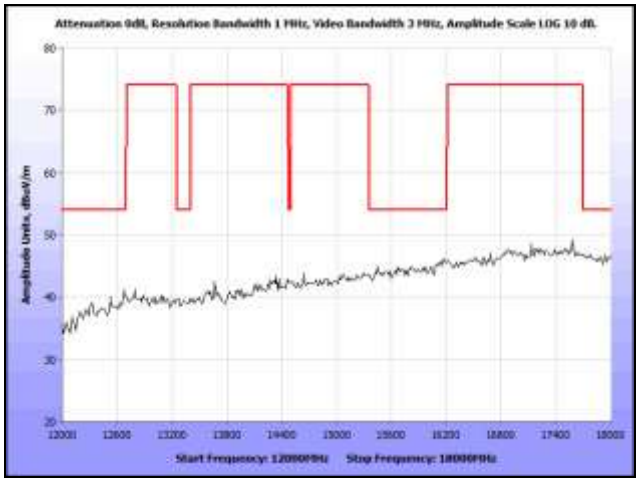
Plot 50. Radiated Spurious Emissions, Mid Channel, 802.11b, 12 GHz – 18 GHz



Plot 51. Radiated Spurious Emissions, High Channel, 802.11b, 30 MHz – 1 GHz

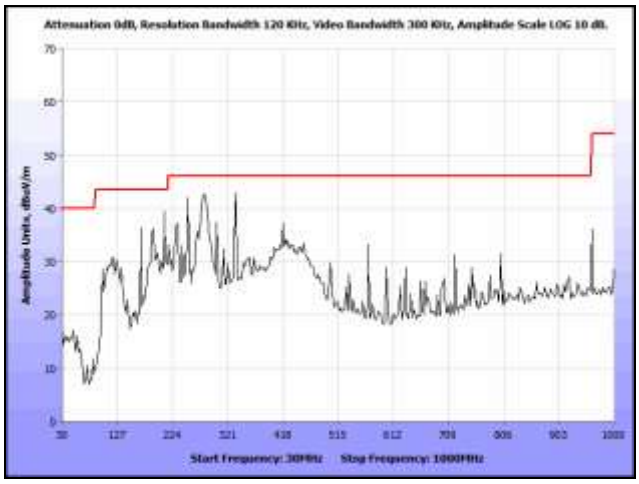


Plot 52. Radiated Spurious Emissions, High Channel, 802.11b, 1 GHz – 12 GHz

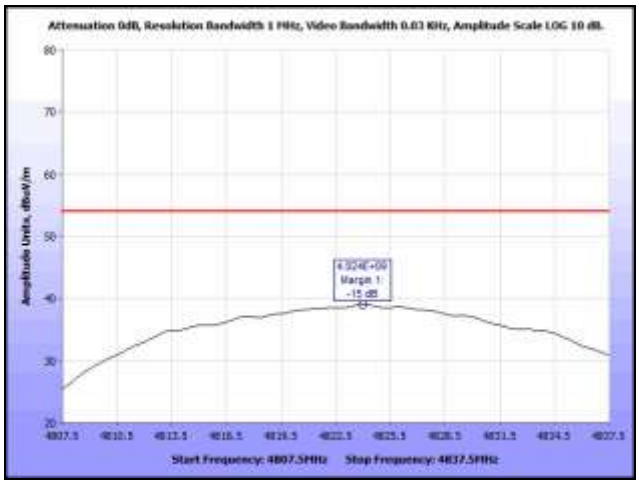


Plot 53. Radiated Spurious Emissions, High Channel, 802.11b, 12 GHz – 18 GHz

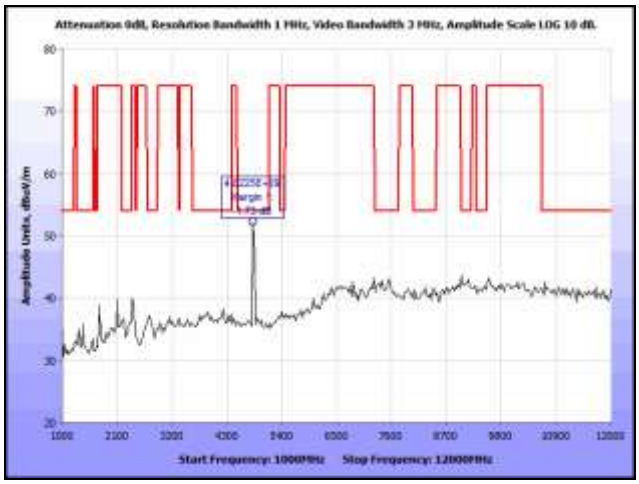
Radiated Spurious Emissions Test Results, 802.11g



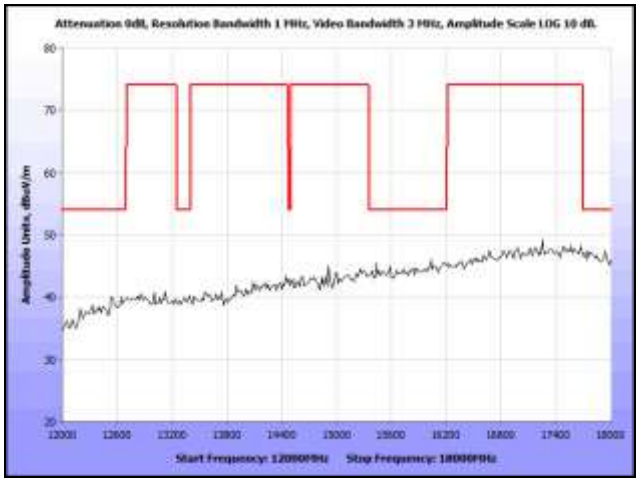
Plot 54. Radiated Spurious Emissions, Low Channel, 802.11g, 30 MHz – 1 GHz



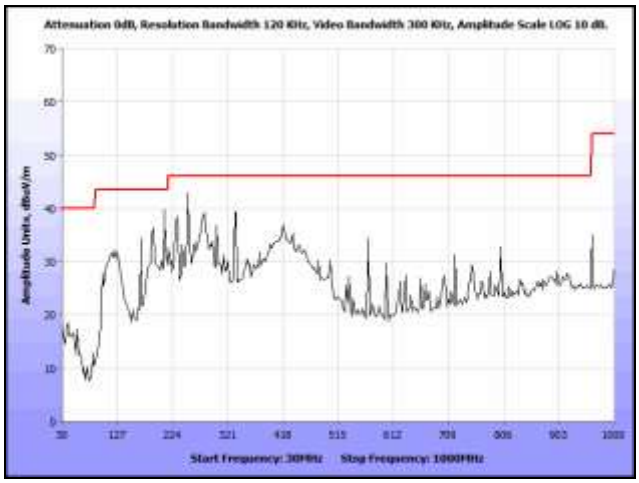
Plot 55. Radiated Spurious Emissions, Low Channel, 802.11g, 1 GHz – 12 GHz (Zoomed 4.824 GHz)



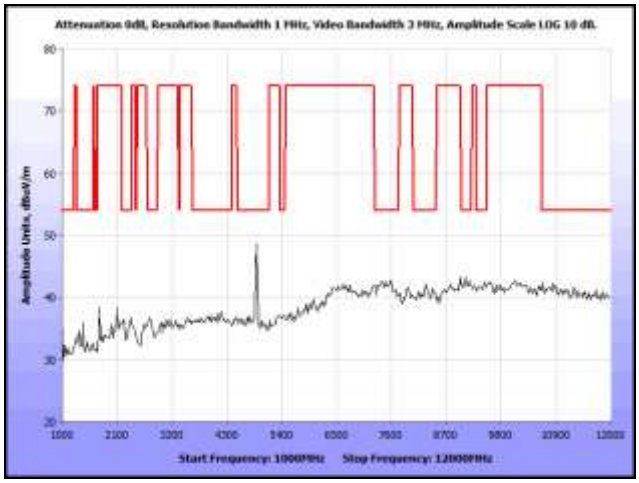
Plot 56. Radiated Spurious Emissions, Low Channel, 802.11g, 1 GHz – 12 GHz



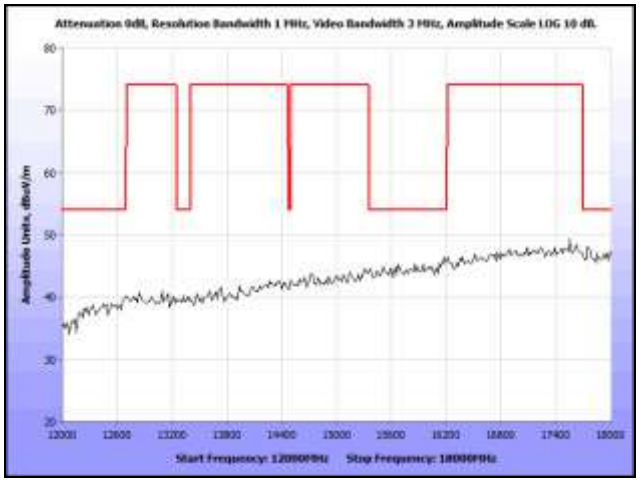
Plot 57. Radiated Spurious Emissions, Low Channel, 802.11g, 12 GHz – 18 GHz



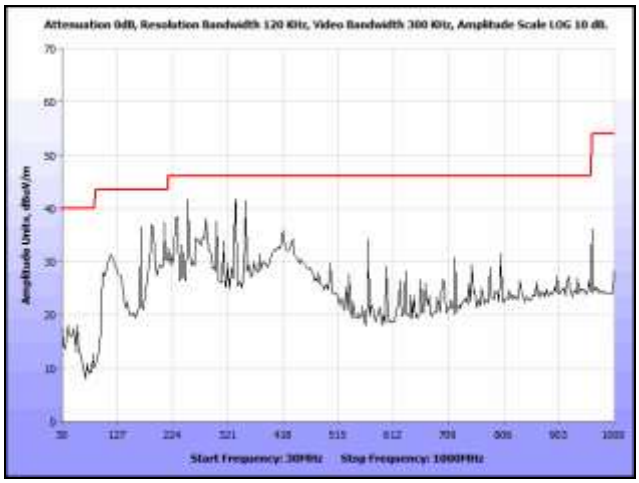
Plot 58. Radiated Spurious Emissions, Mid Channel, 802.11g, 30 MHz – 1 GHz



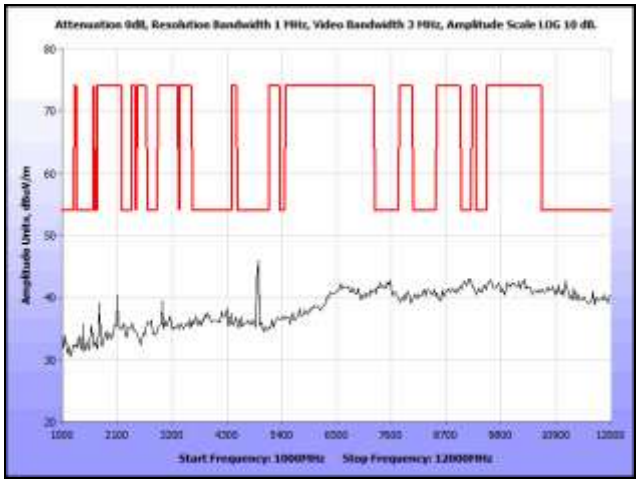
Plot 59. Radiated Spurious Emissions, Mid Channel, 802.11g, 1 GHz – 12 GHz



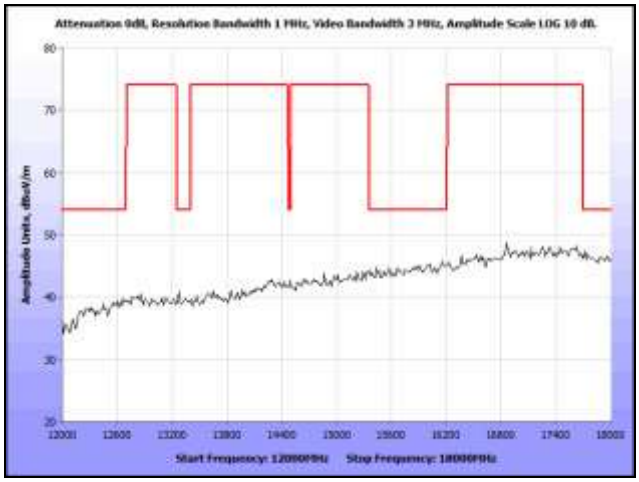
Plot 60. Radiated Spurious Emissions, Mid Channel, 802.11g, 12 GHz – 18 GHz



Plot 61. Radiated Spurious Emissions, High Channel, 802.11g, 30 MHz – 1 GHz

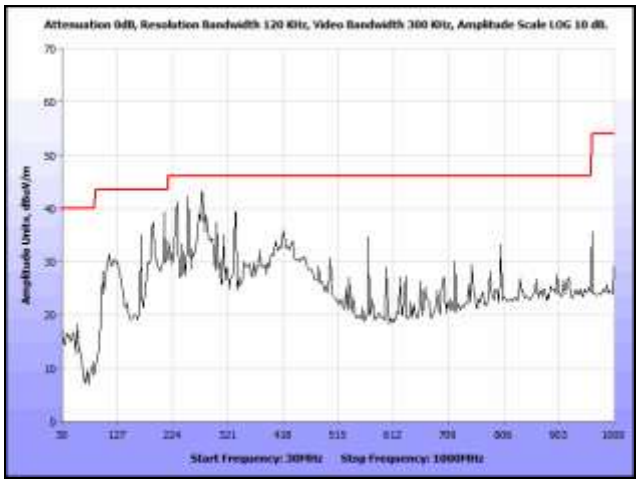


Plot 62. Radiated Spurious Emissions, High Channel, 802.11g, 1 GHz – 12 GHz

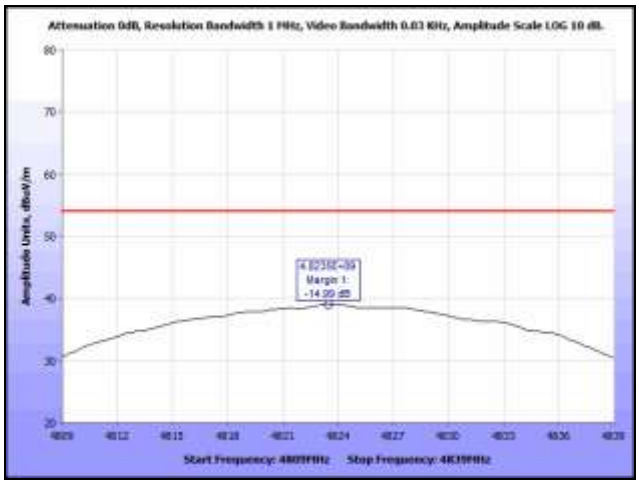


Plot 63. Radiated Spurious Emissions, High Channel, 802.11g, 12 GHz – 18 GHz

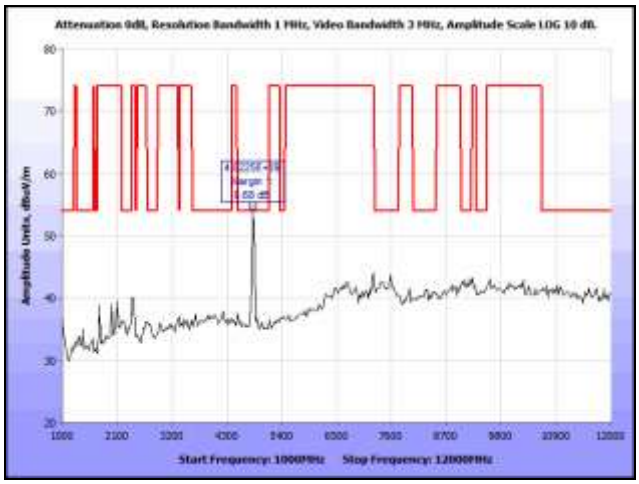
Radiated Spurious Emissions Test Results, 802.11n 20 MHz



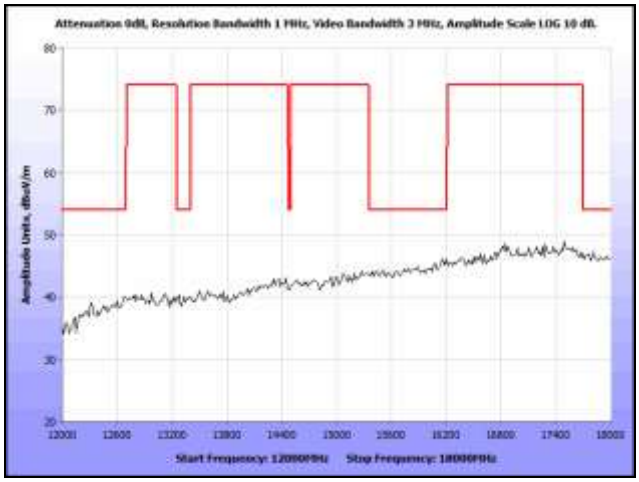
Plot 64. Radiated Spurious Emissions, Low Channel, 802.11n 20 MHz, 30 MHz – 1 GHz



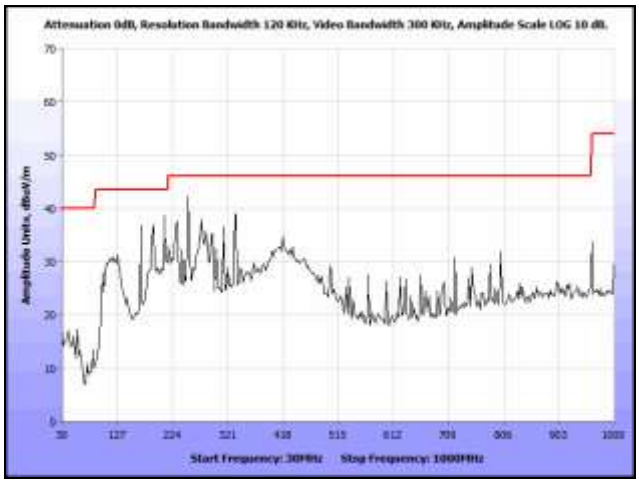
Plot 65. Radiated Spurious Emissions, Low Channel, 802.11n 20 MHz, 1 GHz – 12 GHz (Zoomed 4.824 GHz)



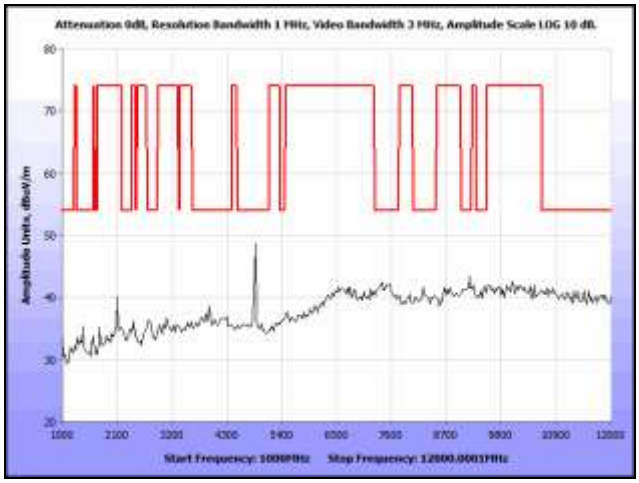
Plot 66. Radiated Spurious Emissions, Low Channel, 802.11n 20 MHz, 1 GHz – 12 GHz



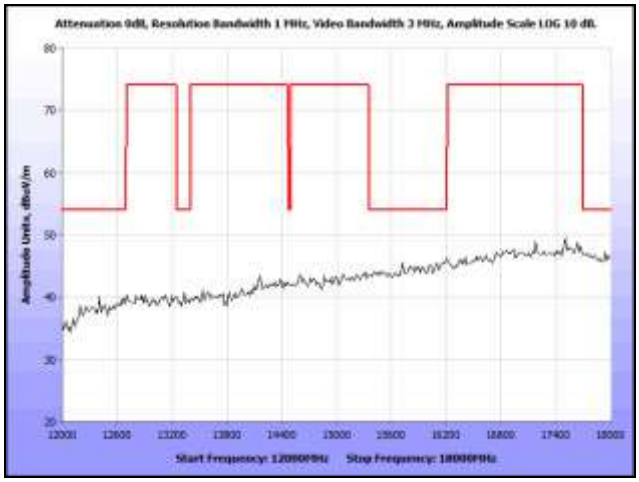
Plot 67. Radiated Spurious Emissions, Low Channel, 802.11n 20 MHz, 12 GHz – 18 GHz



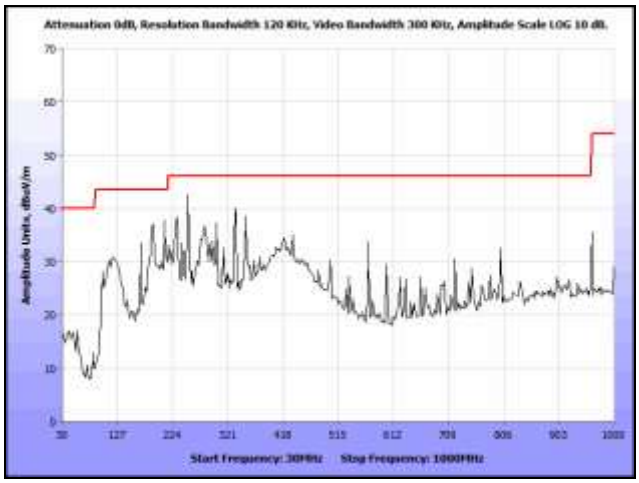
Plot 68. Radiated Spurious Emissions, Mid Channel, 802.11n 20 MHz, 30 MHz – 1 GHz



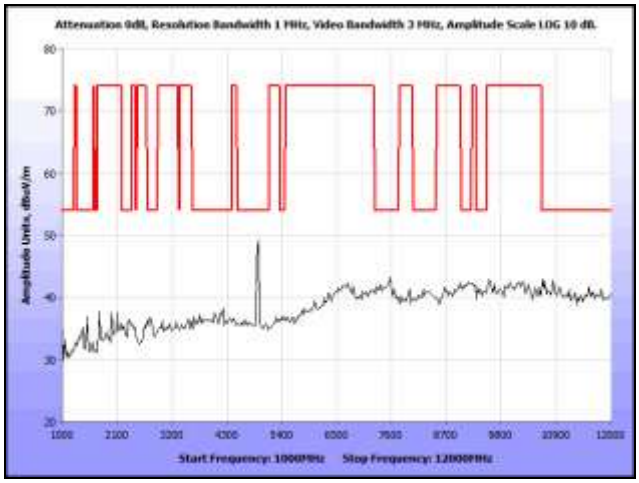
Plot 69. Radiated Spurious Emissions, Mid Channel, 802.11n 20 MHz, 1 GHz – 12 GHz



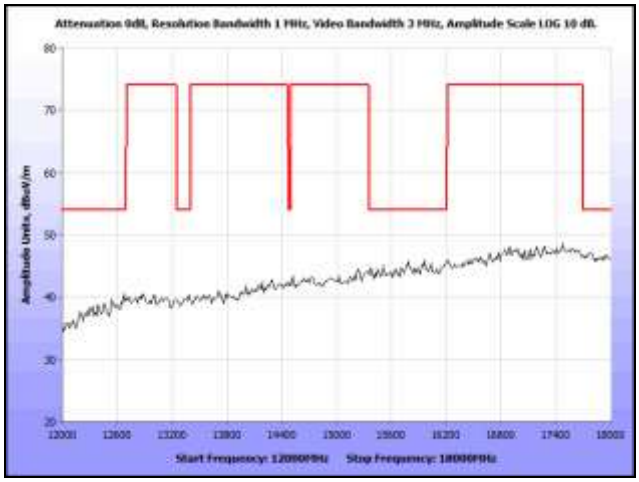
Plot 70. Radiated Spurious Emissions, Mid Channel, 802.11n 20 MHz, 12 GHz – 18 GHz



Plot 71. Radiated Spurious Emissions, High Channel, 802.11n 20 MHz, 30 MHz – 1 GHz

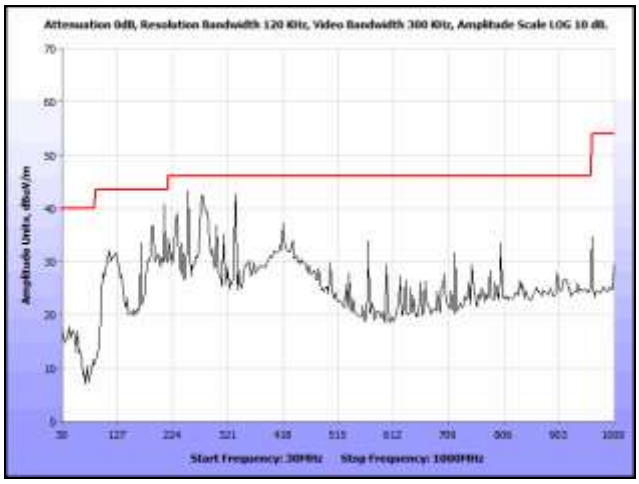


Plot 72. Radiated Spurious Emissions, High Channel, 802.11n 20 MHz, 1 GHz – 12 GHz

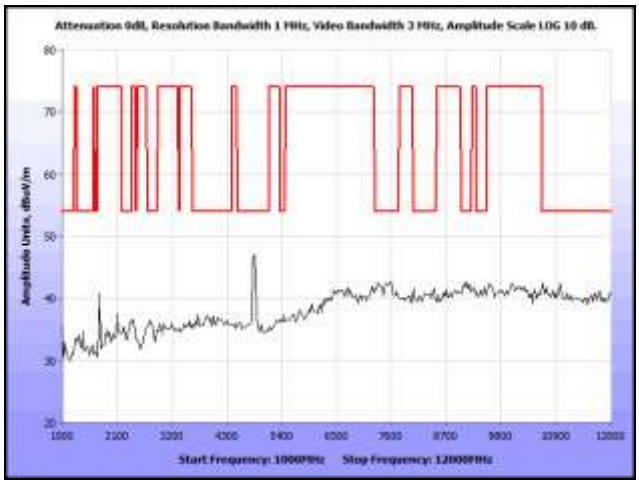


Plot 73. Radiated Spurious Emissions, High Channel, 802.11n 20 MHz, 12 GHz – 18 GHz

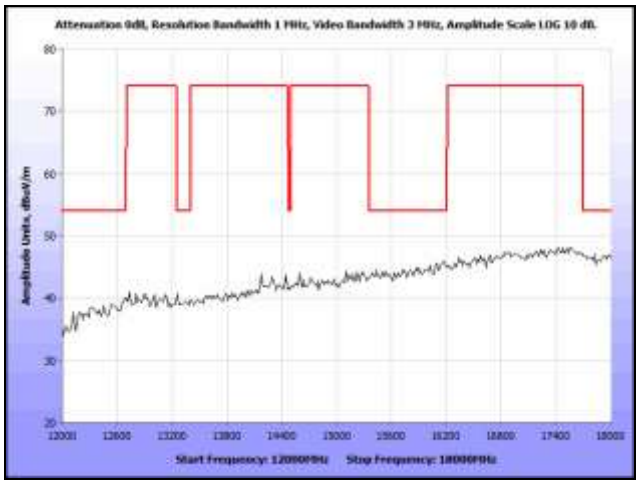
Radiated Spurious Emissions Test Results, 802.11n 40 MHz



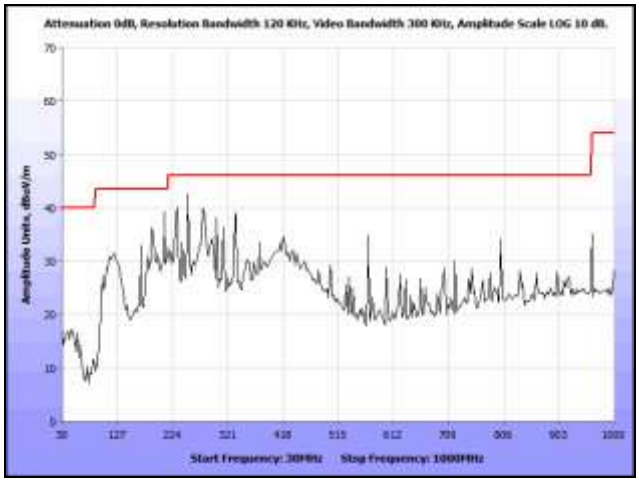
Plot 74. Radiated Spurious Emissions, Low Channel, 802.11n 40 MHz, 30 MHz – 1 GHz



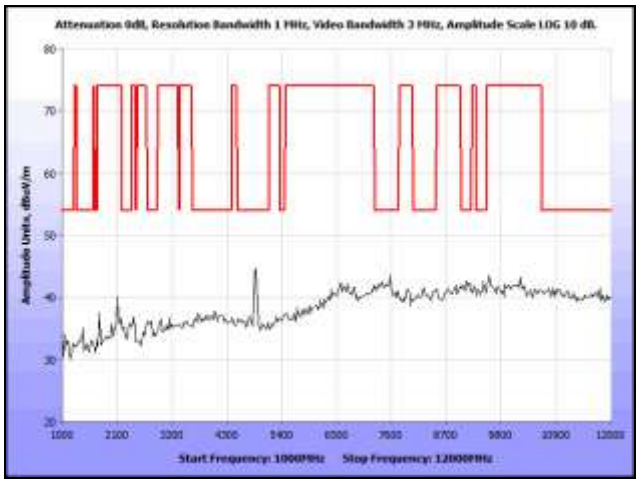
Plot 75. Radiated Spurious Emissions, Low Channel, 802.11n 40 MHz, 1 GHz – 12 GHz



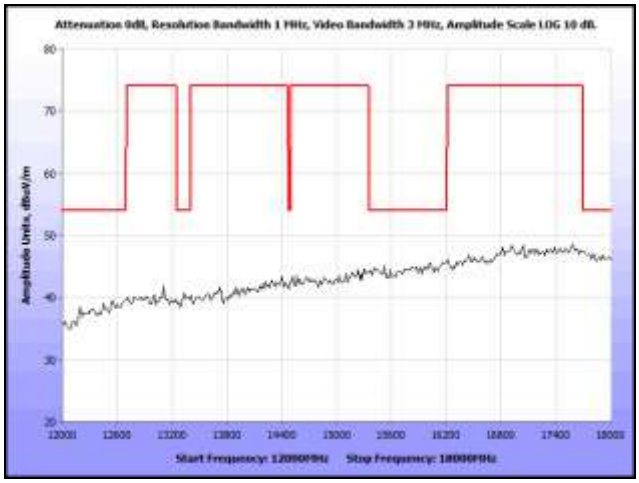
Plot 76. Radiated Spurious Emissions, Low Channel, 802.11n 40 MHz, 12 GHz – 18 GHz



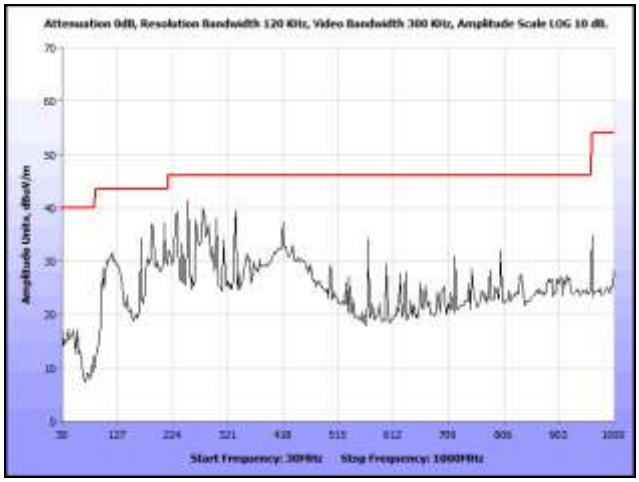
Plot 77. Radiated Spurious Emissions, Mid Channel, 802.11n 40 MHz, 30 MHz – 1 GHz



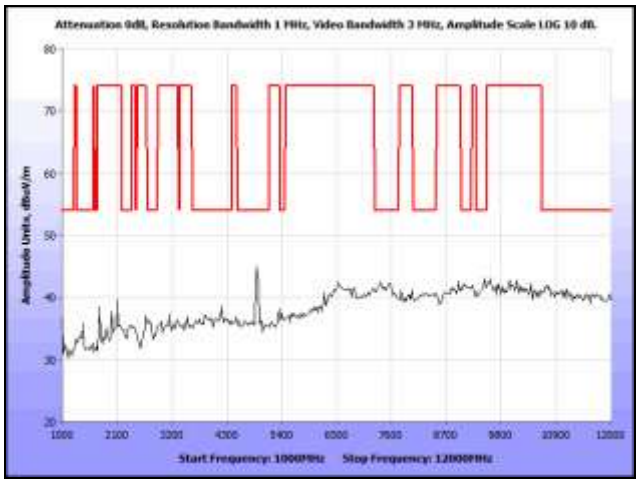
Plot 78. Radiated Spurious Emissions, Mid Channel, 802.11n 40 MHz, 1 GHz – 12 GHz



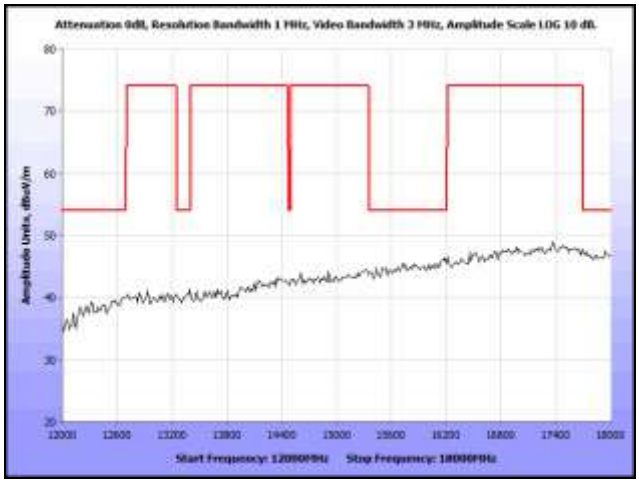
Plot 79. Radiated Spurious Emissions, Mid Channel, 802.11n 40 MHz, 12 GHz – 18 GHz



Plot 80. Radiated Spurious Emissions, High Channel, 802.11n 40 MHz, 30 MHz – 1 GHz



Plot 81. Radiated Spurious Emissions, High Channel, 802.11n 40 MHz, 1 GHz – 12 GHz

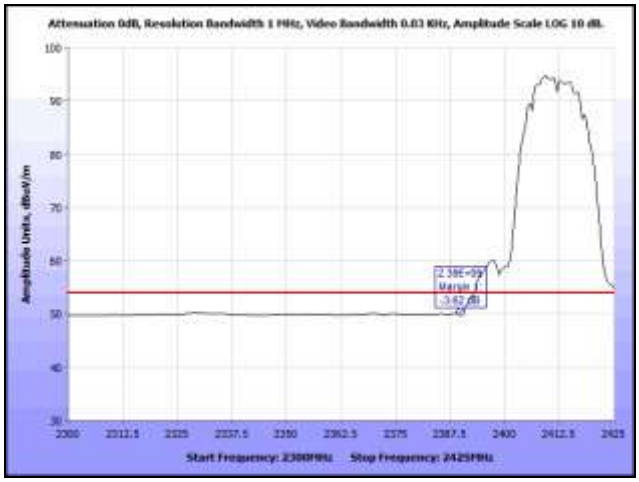


Plot 82. Radiated Spurious Emissions, High Channel, 802.11n 40 MHz, 12 GHz – 18 GHz

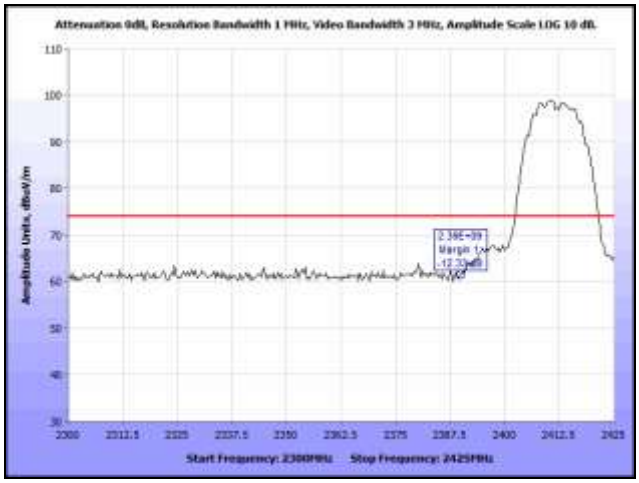
Radiated Band Edge Measurements

Test Procedures: The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and cable loss and compared to a 3 m limit line.

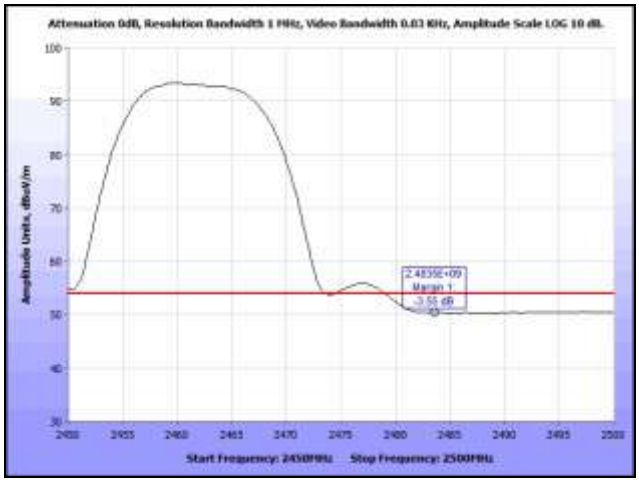
Radiated Band Edge Measurements, 802.11b



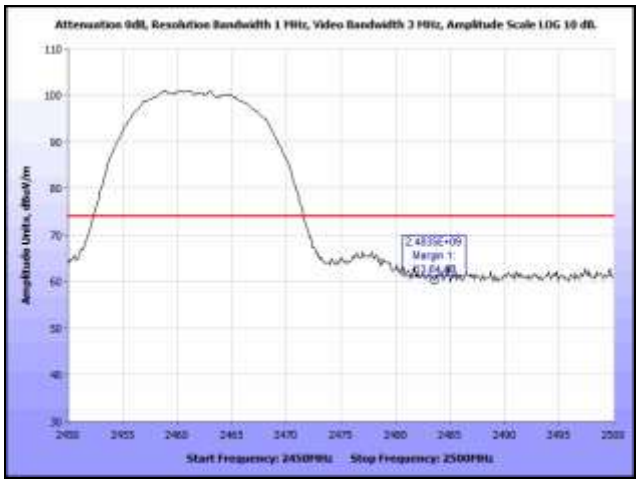
Plot 83. Radiated Band Edge, 802.11b, Low Channel, Average



Plot 84. Radiated Band Edge, 802.11b, Low Channel, Peak

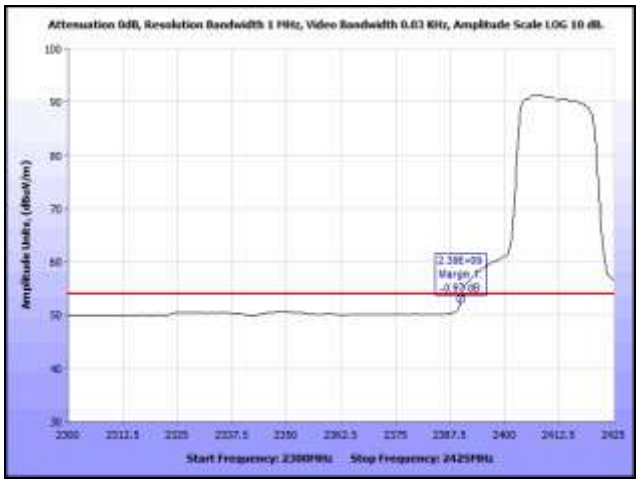


Plot 85. Radiated Band Edge, 802.11b, High Channel, Average

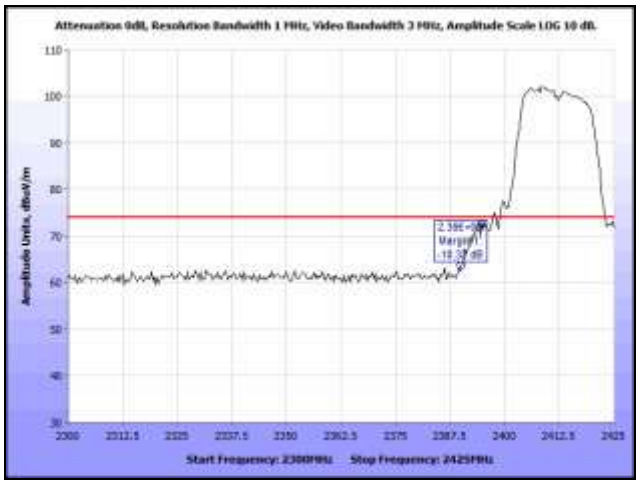


Plot 86. Radiated Band Edge, 802.11b, High Channel, Peak

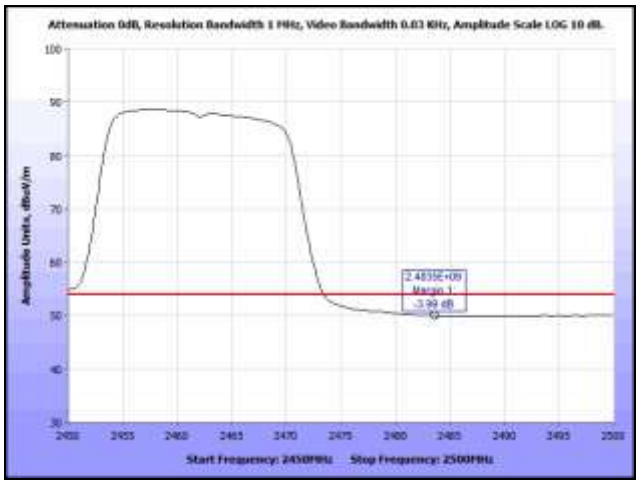
Radiated Band Edge Measurements, 802.11g



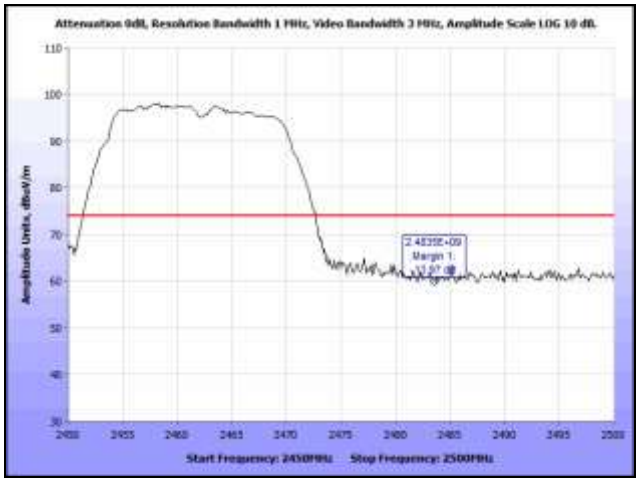
Plot 87. Radiated Band Edge, 802.11g, Low Channel, Average



Plot 88. Radiated Band Edge, 802.11g, Low Channel, Peak

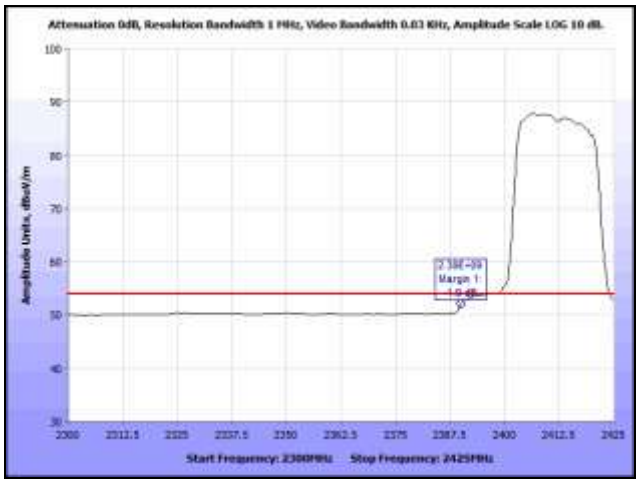


Plot 89. Radiated Band Edge, 802.11g, High Channel, Average

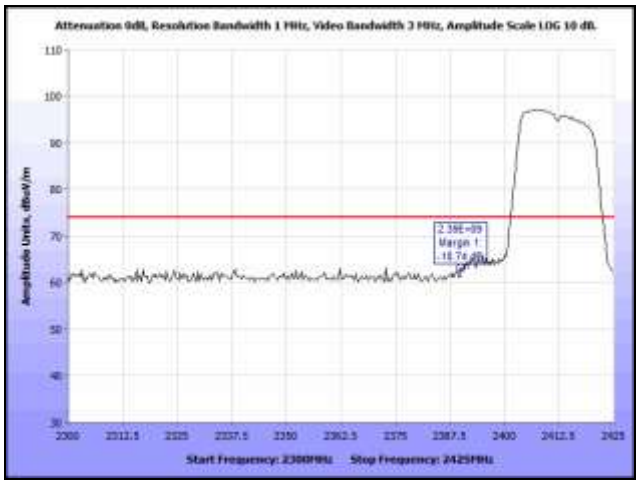


Plot 90. Radiated Band Edge, 802.11g, High Channel, Peak

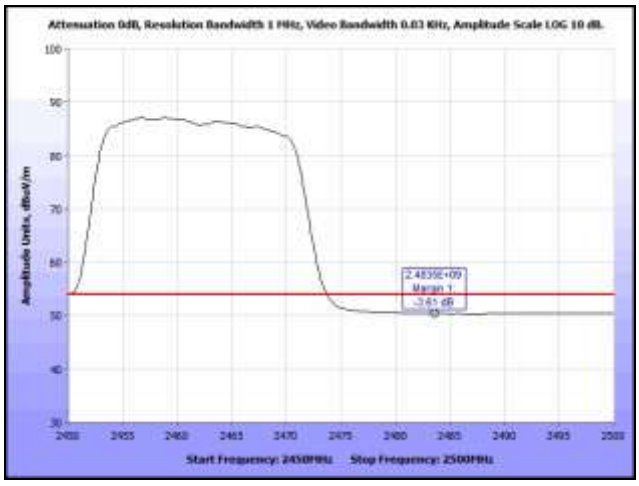
Radiated Band Edge Measurements, 802.11n 20 MHz



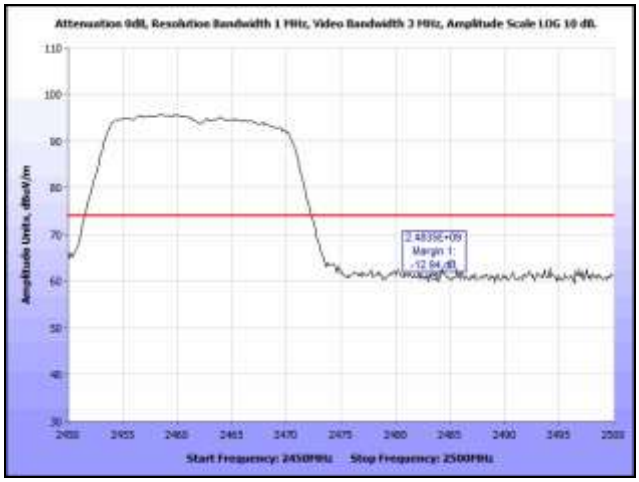
Plot 91. Radiated Band Edge, 802.11n 20MHz, Low Channel, Average



Plot 92. Radiated Band Edge, 802.11n 20MHz, Low Channel, Peak

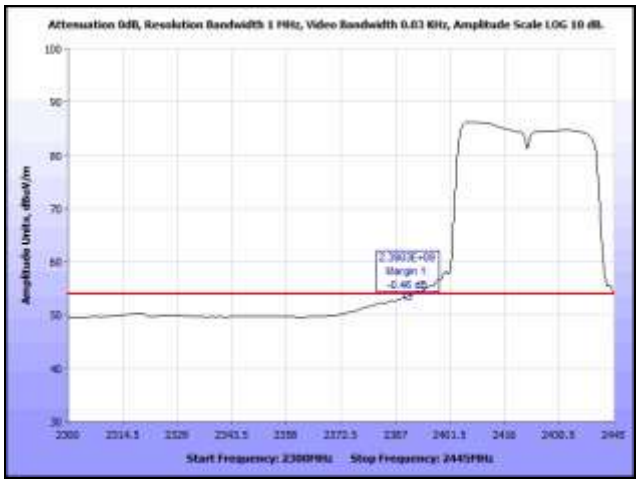


Plot 93. Radiated Band Edge, 802.11n 20MHz, High Channel, Average

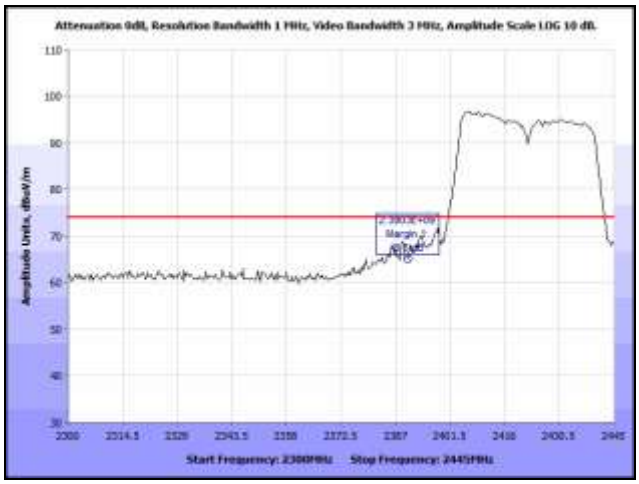


Plot 94. Radiated Band Edge, 802.11n 20MHz, High Channel, Peak

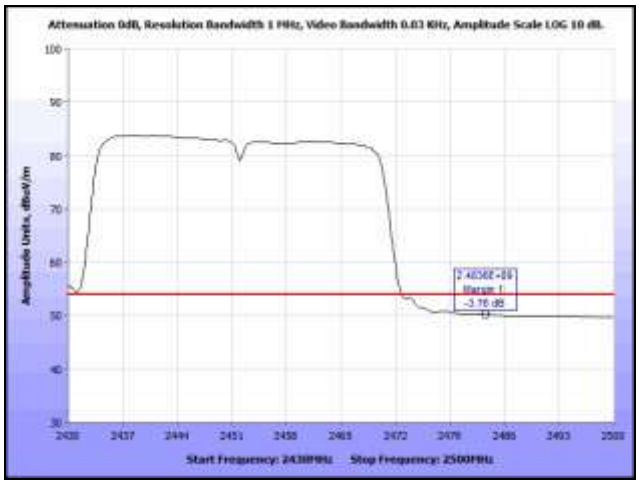
Radiated Band Edge Measurements, 802.11n 40 MHz



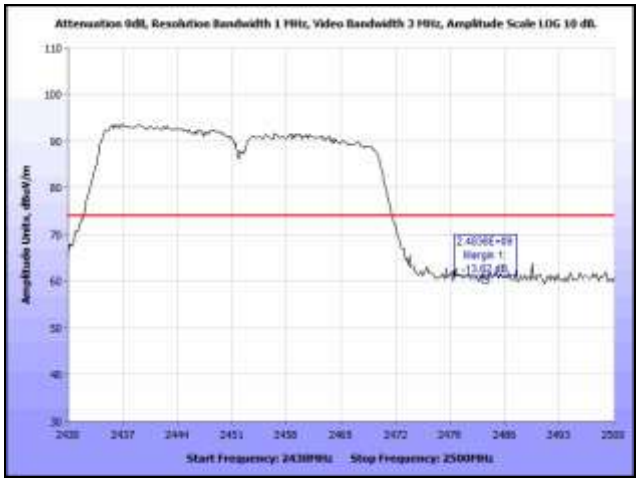
Plot 95. Radiated Band Edge, 802.11n 40MHz, Low Channel, Average



Plot 96. Radiated Band Edge, 802.11n 40MHz, Low Channel, Peak



Plot 97. Radiated Band Edge, 802.11n 40MHz, High Channel, Average



Plot 98. Radiated Band Edge, 802.11n 40MHz, High Channel, Peak

Radiated Spurious Emissions Test Setup

Photograph 8. Radiated Spurious Emissions, Test Setup, 30 MHz – 1 GHz

Photograph 9. Radiated Spurious Emissions, Test Setup, 1 GHz – 18 GHz

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) RF Conducted Spurious Emissions Requirements and Band Edge

Test Requirement: **15.247(d)** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Test Procedure: For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

A conducted sample was provided fitted with a SMA connector. The EUT was connected from the SMA connector to a spectrum analyzer using a 10 dB Attenuator. Testing was performed on Low, Mid and High Channels. A resolution bandwidth of 100 kHz and video bandwidth of 300 kHz were utilized.

For conducted band edge, a delta measurement was taken from the peak of the fundamental to the Band edge then compared to the limit.

Test Results: The EUT was compliant with the Conducted Spurious Emission limits of **§15.247(d)**.

Test Engineer(s): Anderson Soungpanya

Test Date(s): 05/14/12

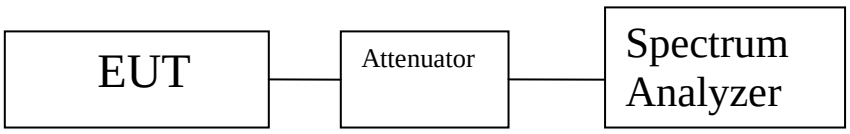
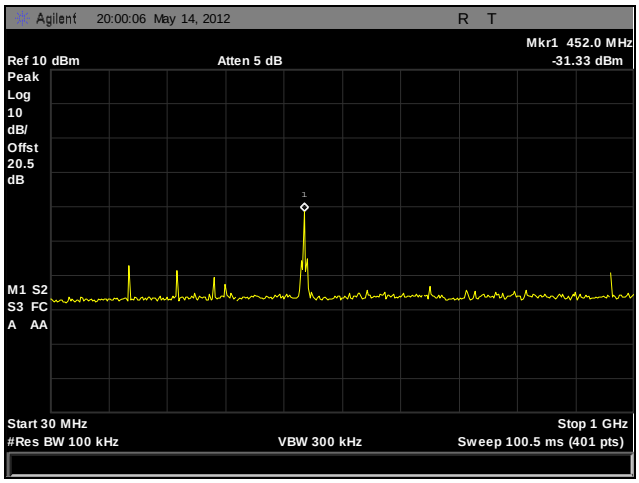
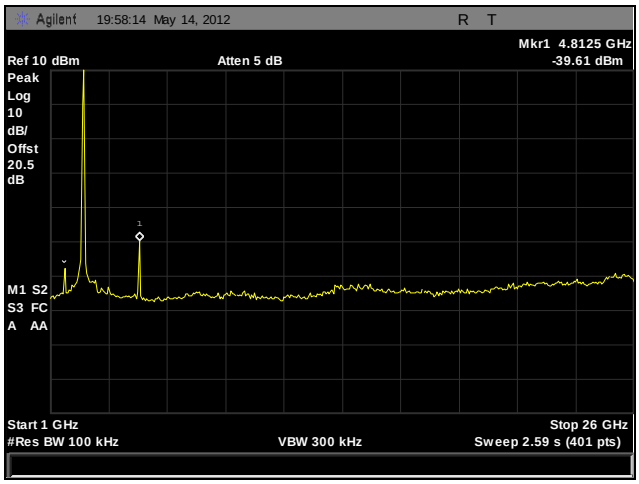


Figure 4. Block Diagram, Conducted Spurious Emissions Test Setup

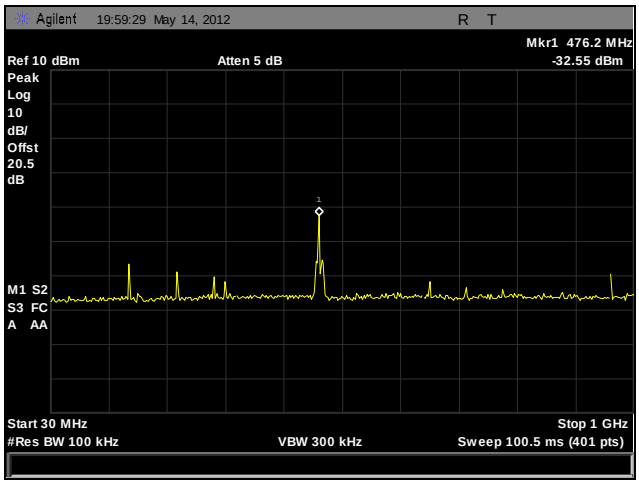
Conducted Spurious Emissions Test Results, 802.11b



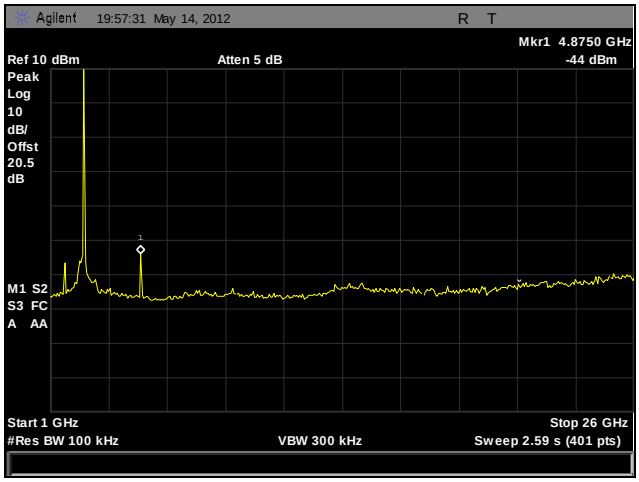
Plot 99. Conducted Spurious Emissions, Low Channel, 30 MHz – 1 GHz, 802.11b



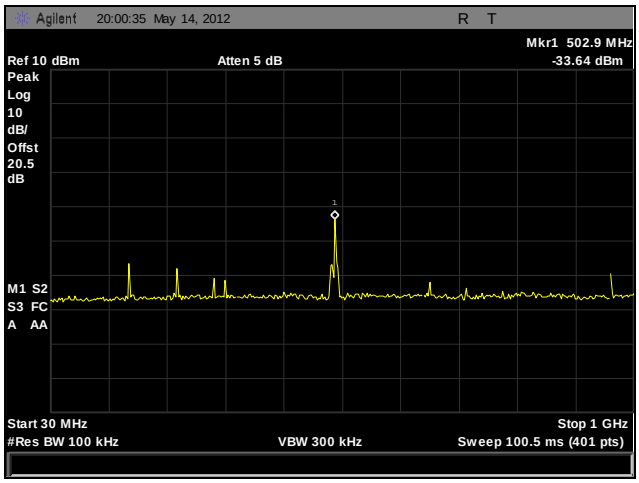
Plot 100. Conducted Spurious Emissions, Low Channel, 1 GHz – 26 GHz, 802.11b



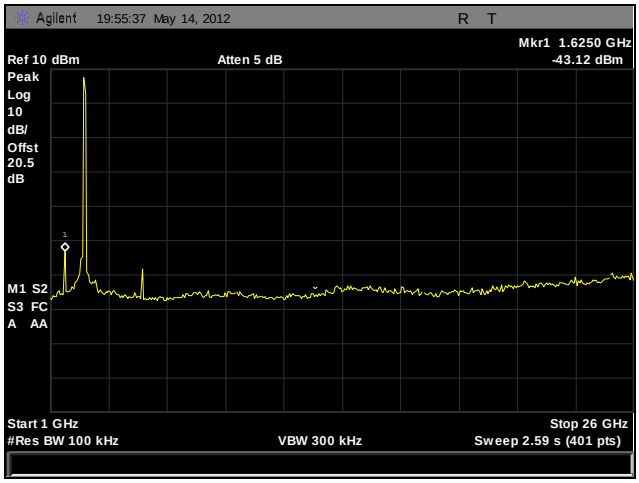
Plot 101. Conducted Spurious Emissions, Mid Channel, 30 MHz – 1 GHz, 802.11b



Plot 102. Conducted Spurious Emissions, Mid Channel, 1 GHz – 26 GHz, 802.11b

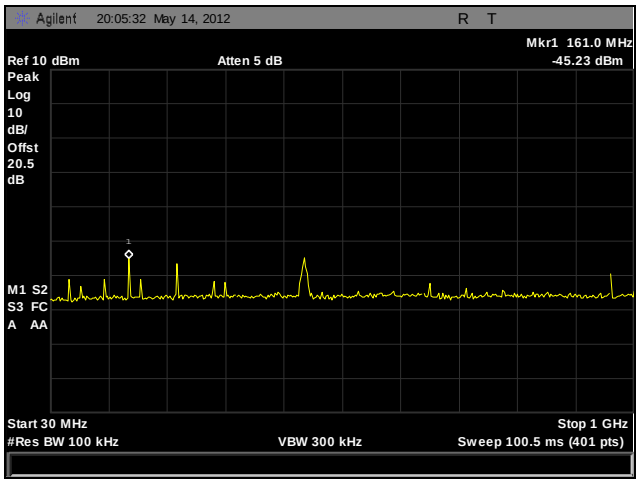


Plot 103. Conducted Spurious Emissions, High Channel, 30 MHz – 1 GHz, 802.11b

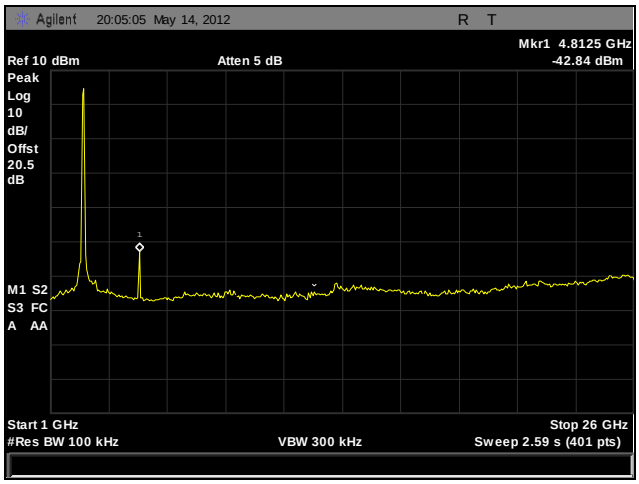


Plot 104. Conducted Spurious Emissions, High Channel, 1 GHz – 26 GHz, 802.11b

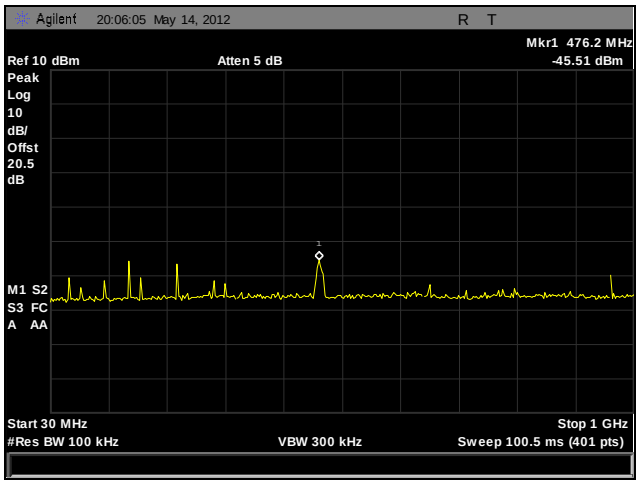
Conducted Spurious Emissions Test Results, 802.11g



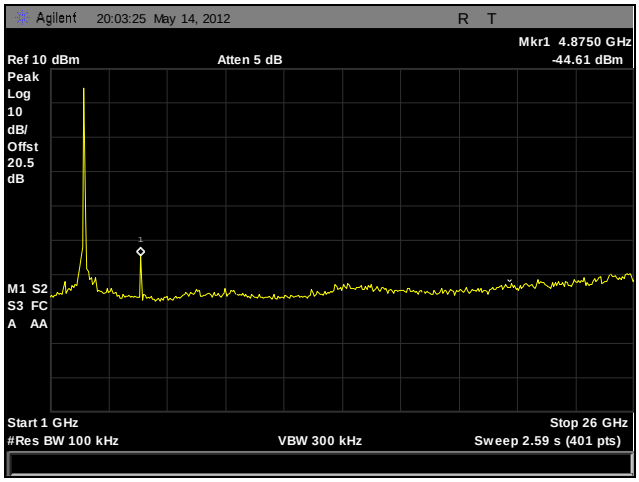
Plot 105. Conducted Spurious Emissions, Low Channel, 30 MHz – 1 GHz, 802.11g



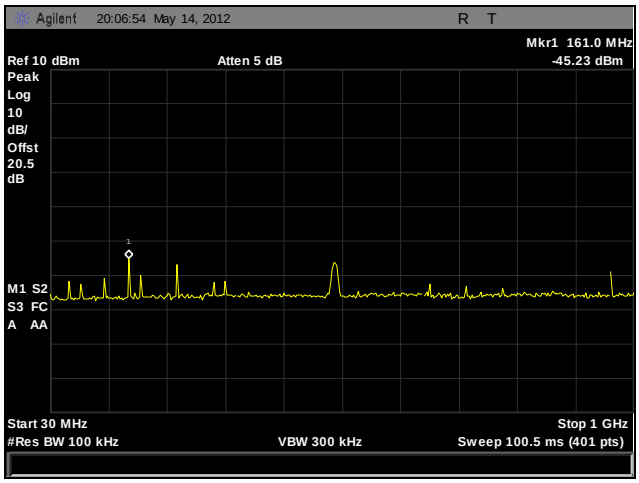
Plot 106. Conducted Spurious Emissions, Low Channel, 1 GHz – 26 GHz, 802.11g



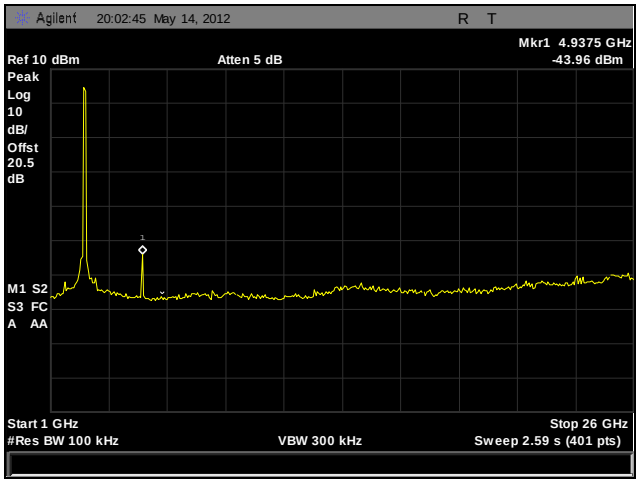
Plot 107. Conducted Spurious Emissions, Mid Channel, 30 MHz – 1 GHz, 802.11g



Plot 108. Conducted Spurious Emissions, Mid Channel, 1 GHz – 26 GHz, 802.11g

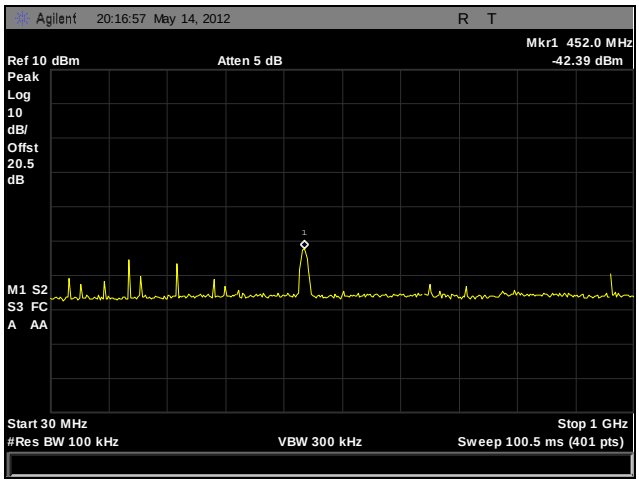


Plot 109. Conducted Spurious Emissions, High Channel, 30 MHz – 1 GHz, 802.11g

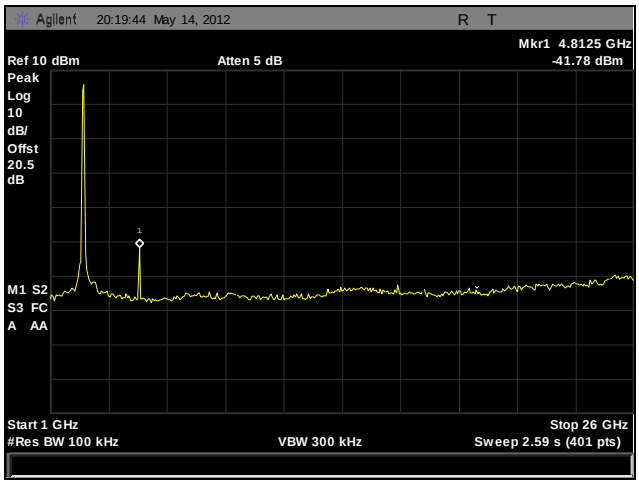


Plot 110. Conducted Spurious Emissions, High Channel, 1 GHz – 26 GHz, 802.11g

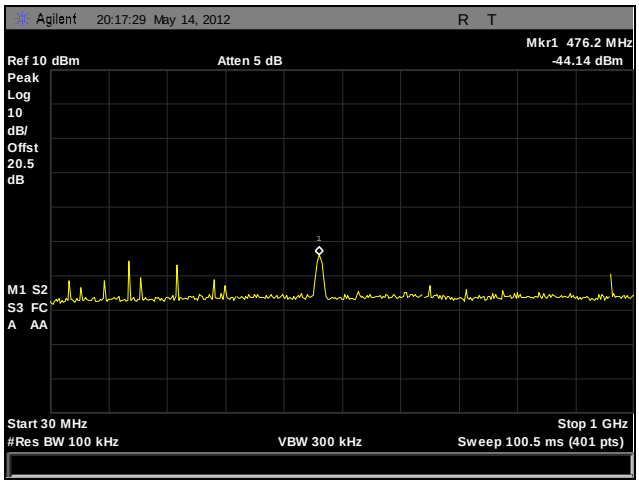
Conducted Spurious Emissions Test Results, 802.11n 20 MHz



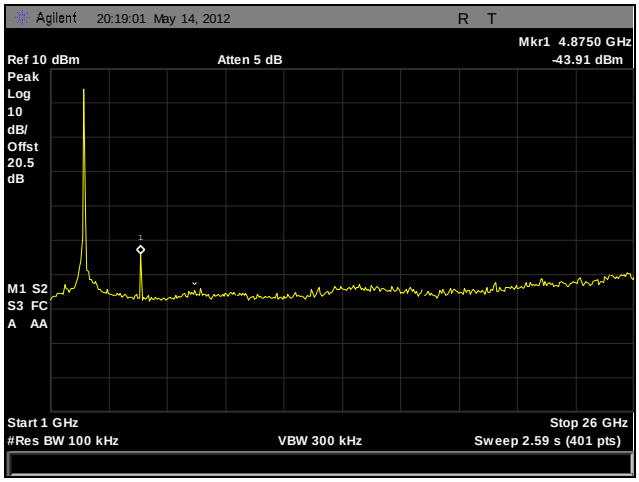
Plot 111. Conducted Spurious Emissions, Low Channel, 30 MHz – 1 GHz, 802.11n 20 MHz



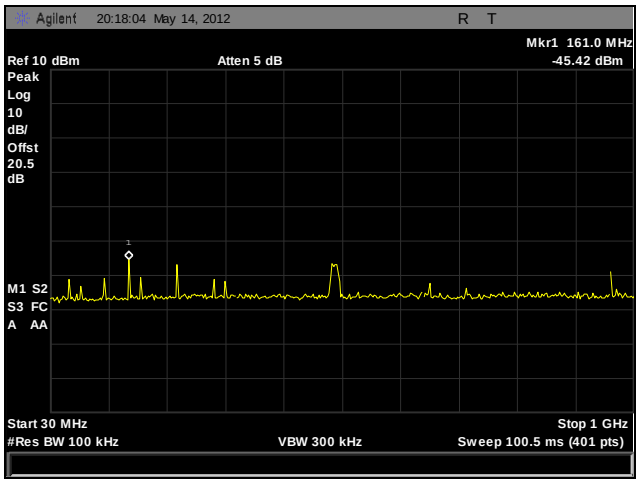
Plot 112. Conducted Spurious Emissions, Low Channel, 1 GHz – 26 GHz, 802.11n 20 MHz



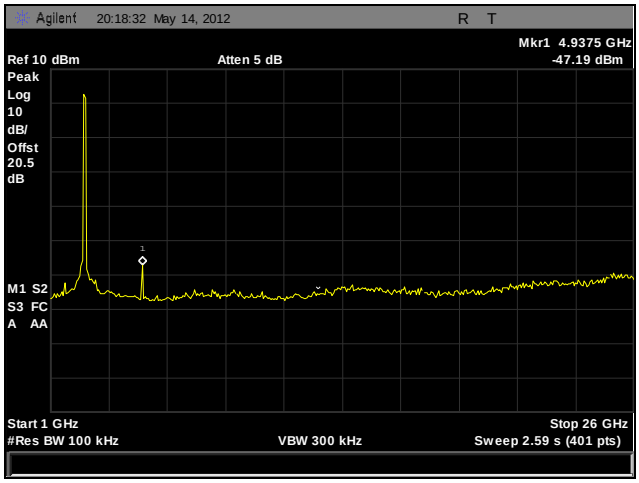
Plot 113. Conducted Spurious Emissions, Mid Channel, 30 MHz – 1 GHz, 802.11n 20 MHz



Plot 114. Conducted Spurious Emissions, Mid Channel, 1 GHz – 26 GHz, 802.11n 20 MHz

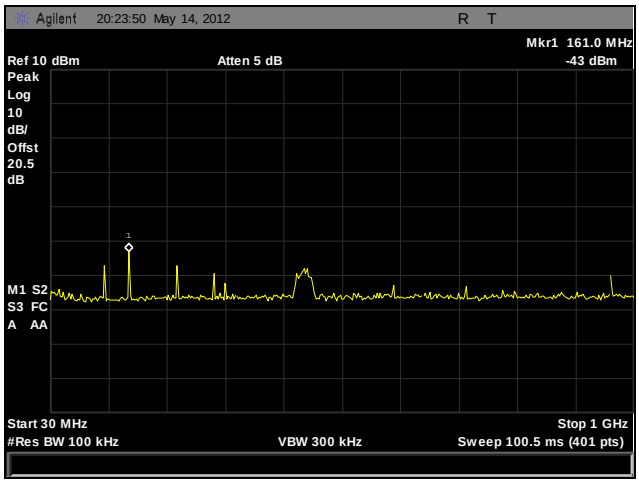


Plot 115. Conducted Spurious Emissions, High Channel, 30 MHz – 1 GHz, 802.11n 20 MHz

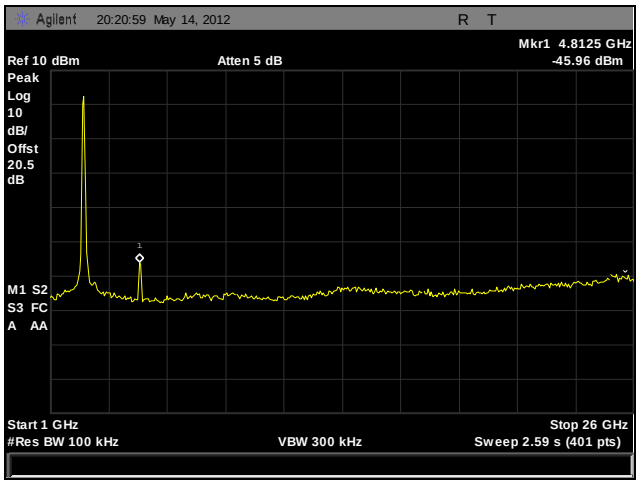


Plot 116. Conducted Spurious Emissions, High Channel, 1 GHz – 26 GHz, 802.11n 20 MHz

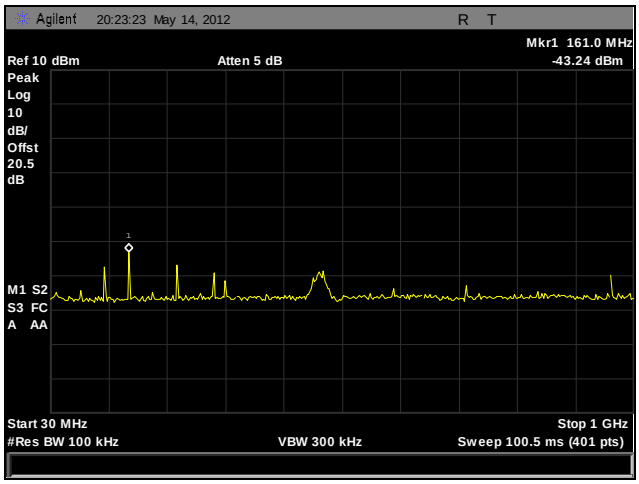
Conducted Spurious Emissions Test Results, 802.11n 40 MHz



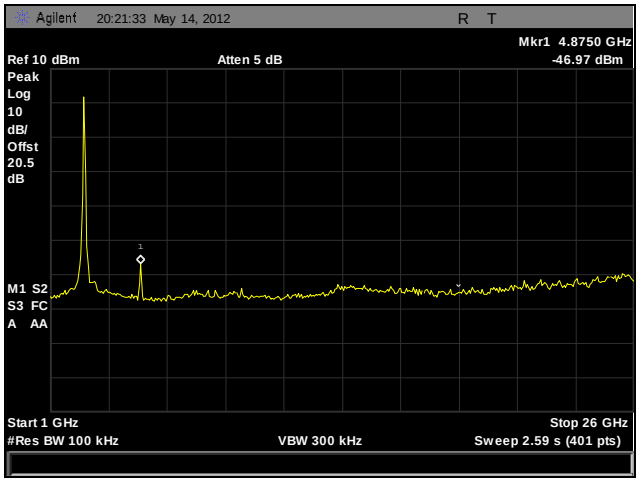
Plot 117. Conducted Spurious Emissions, Low Channel, 30 MHz – 1 GHz, 802.11n 40 MHz



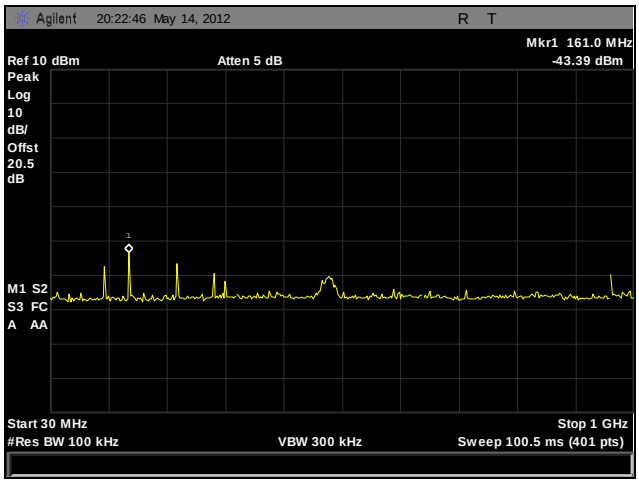
Plot 118. Conducted Spurious Emissions, Low Channel, 1 GHz – 26 GHz, 802.11n 40 MHz



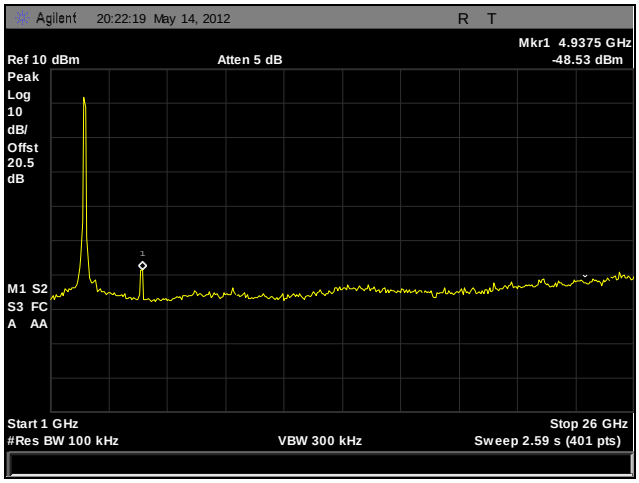
Plot 119. Conducted Spurious Emissions, Mid Channel, 30 MHz – 1 GHz, 802.11n 40 MHz



Plot 120. Conducted Spurious Emissions, Mid Channel, 1 GHz – 26 GHz, 802.11n 40 MHz

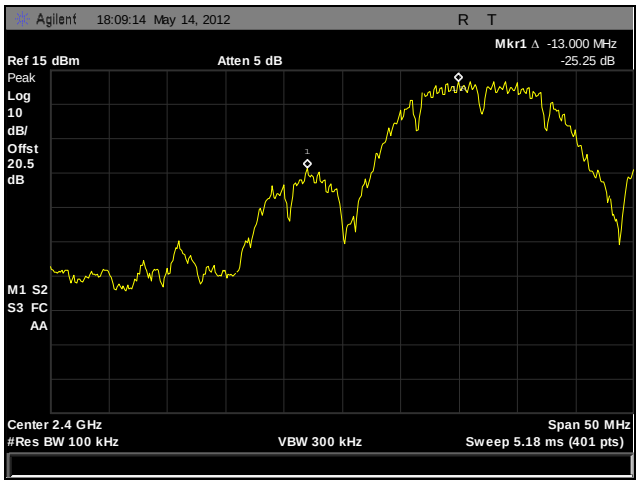


Plot 121. Conducted Spurious Emissions, High Channel, 30 MHz – 1 GHz, 802.11n 40 MHz

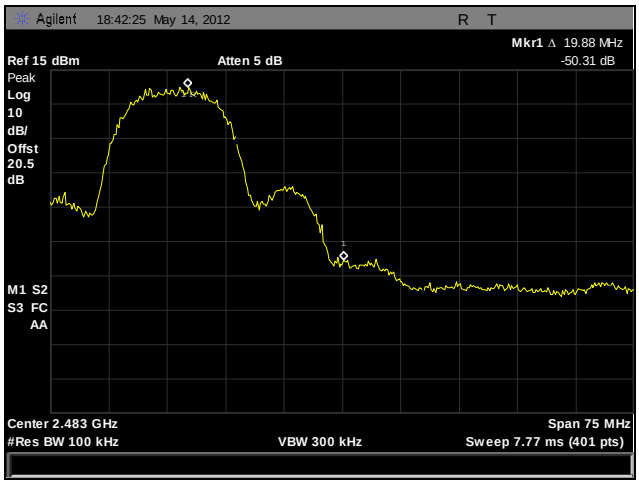


Plot 122. Conducted Spurious Emissions, High Channel, 1 GHz – 26 GHz, 802.11n 40 MHz

Conducted Band Edge Test Results, 802.11b

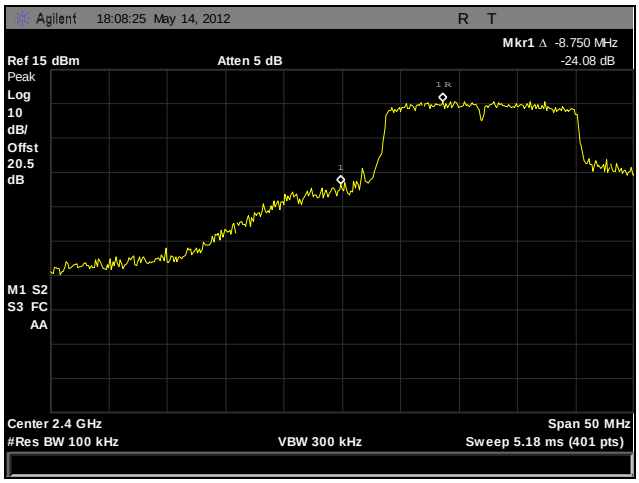


Plot 123. Conducted Band Edge, Low Channel, 802.11b

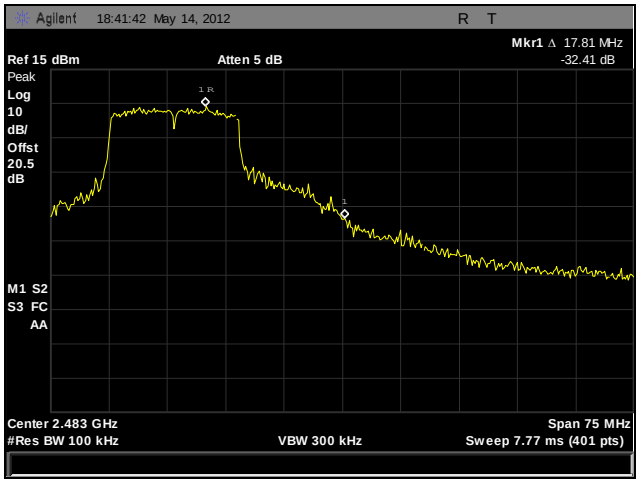


Plot 124. Conducted Band Edge, High Channel, 802.11b

Conducted Band Edge Test Results, 802.11g

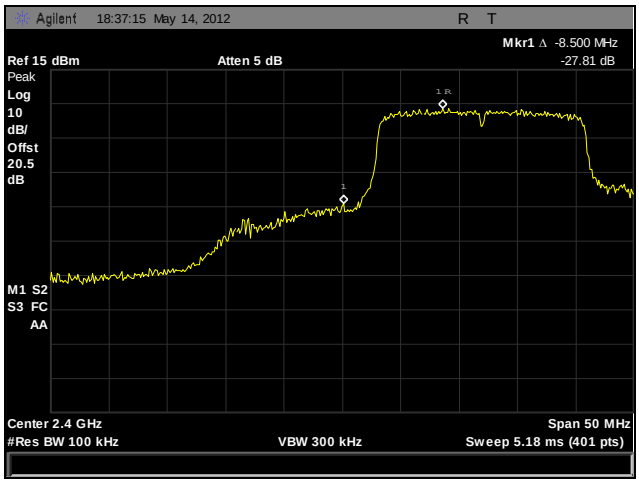


Plot 125. Conducted Band Edge, Low Channel, 802.11g

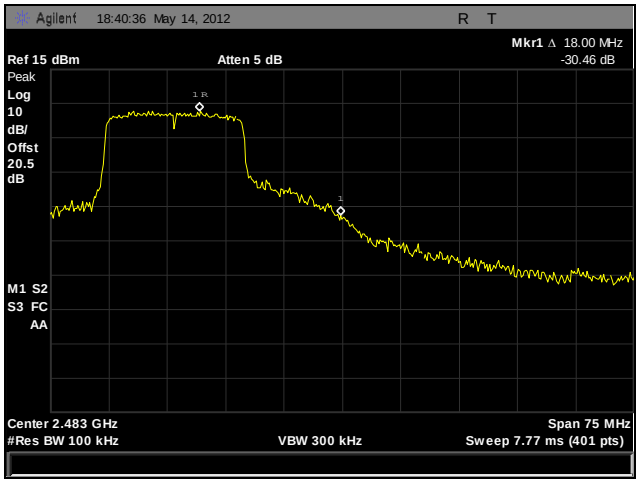


Plot 126. Conducted Band Edge, High Channel, 802.11g

Conducted Band Edge Test Results, 802.11n 20 MHz

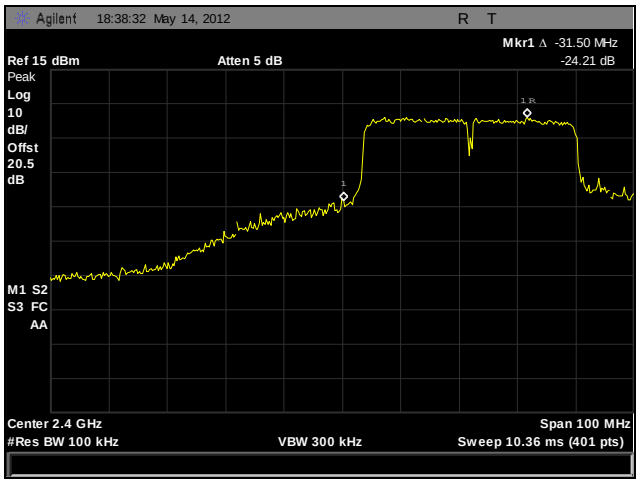


Plot 127. Conducted Band Edge, Low Channel, 802.11n 20 MHz

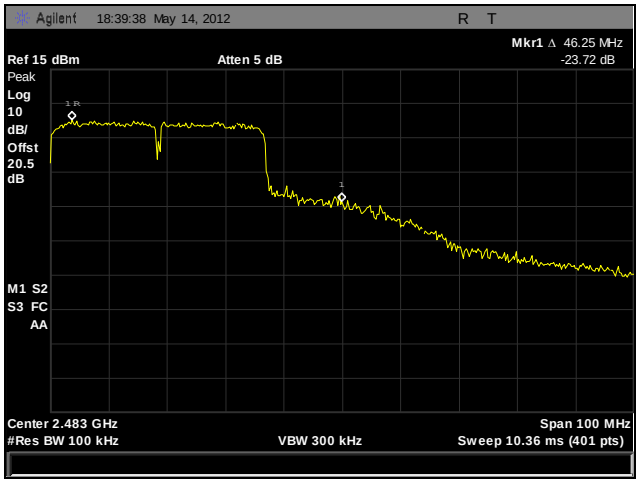


Plot 128. Conducted Band Edge, High Channel, 802.11n 20 MHz

Conducted Band Edge Test Results, 802.11n 40 MHz



Plot 129. Conducted Band Edge, Low Channel, 802.11n 40 MHz



Plot 130. Conducted Band Edge, High Channel, 802.11n 40 MHz

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(e) Peak Power Spectral Density

Test Procedure: The transmitter was connected directly to a Spectrum Analyzer through an attenuator. The power level was set to the maximum level. A RBW of 1 MHz and VBW of 3 MHz were used to determine the peak emissions within the band. The Spectrum analyzer was then set to a RBW of 3 kHz and VBW was set to 10 kHz. The SPAN of the analyzer was set to 1 MHz with a 333.3 second sweep. Measurements were carried out at the low, mid and high channels.

Test Results: The EUT was compliant with the peak power spectral density limits of **§ 15.247 (e)**.

The peak power spectral density was determined from plots on the following page(s).

Test Engineer: Anderson Soungpanya

Test Date: 05/30/12

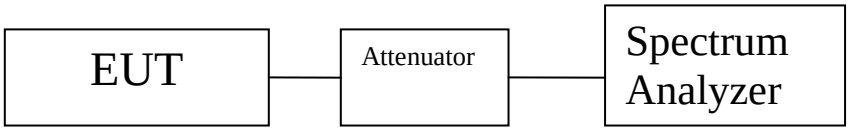


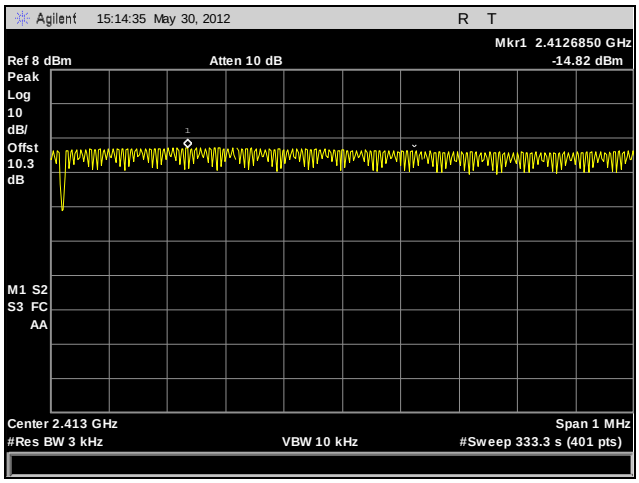
Figure 5. Block Diagram, Peak Power Spectral Density Test Setup

Peak Power Spectral Density Test Results

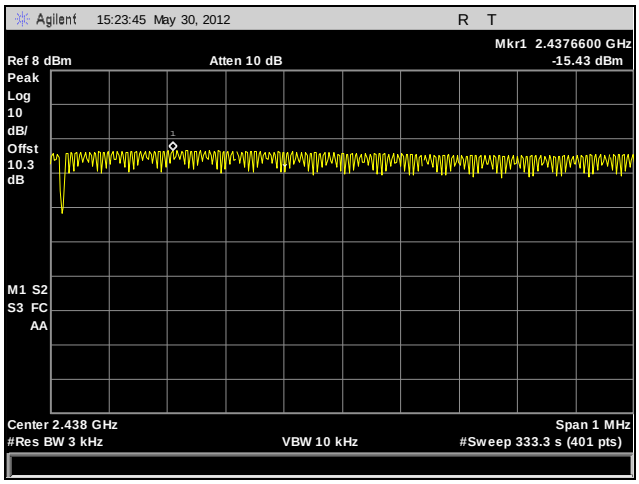
Peak Power Spectral Density					
Mode	**Carrier Channel**	**Frequency (MHz)**	**Measured PPSD (dBm)**	**Limit (dBm)**	**Margin (dB)**
802.11b	Low	2412	-14.82	8	-22.82
	Mid	2437	-15.43	8	-23.43
	High	2462	-16.84	8	-24.84
802.11g	Low	2412	-10.75	8	-18.75
	Mid	2437	-12.47	8	-20.47
	High	2462	-13.27	8	-21.27
802.11n 20 MHz	Low	2412	-11.90	8	-19.90
	Mid	2437	-12.24	8	-20.24
	High	2462	-13.44	8	-21.44
802.11n 40 MHz	Low	2422	-13.51	8	-21.51
	Mid	2437	-14.60	8	-22.60
	High	2452	-14.47	8	-22.47

Table 24. Peak Power Spectral Density, Test Results

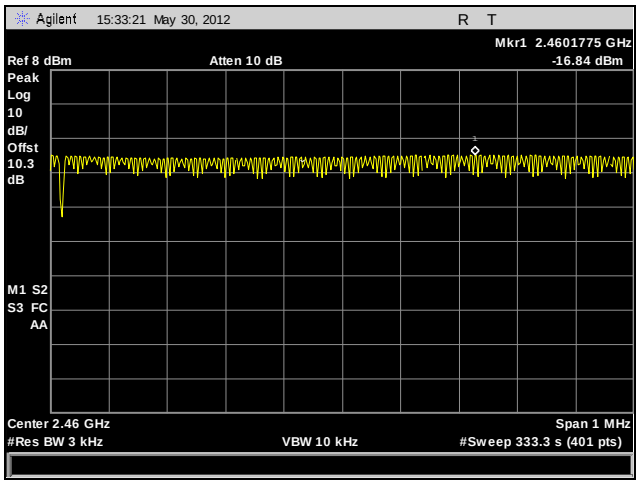
Peak Power Spectral Density, 802.11b



Plot 131. Peak Power Spectral Density, Low Channel, 802.11b

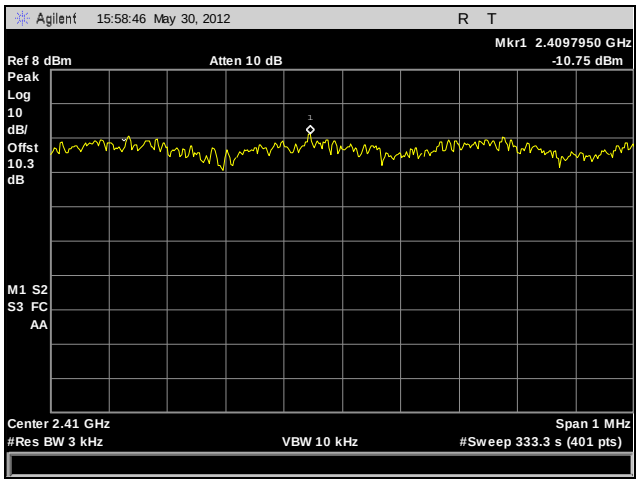


Plot 132. Peak Power Spectral Density, Mid Channel, 802.11b

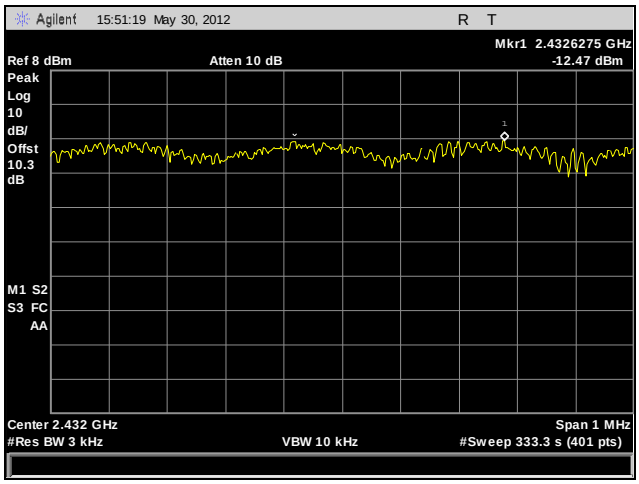


Plot 133. Peak Power Spectral Density, High Channel, 802.11b

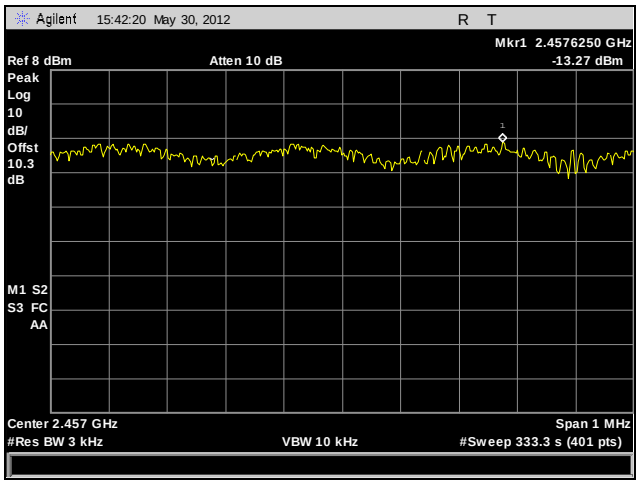
Peak Power Spectral Density, 802.11g



Plot 134. Peak Power Spectral Density, Low Channel, 802.11g

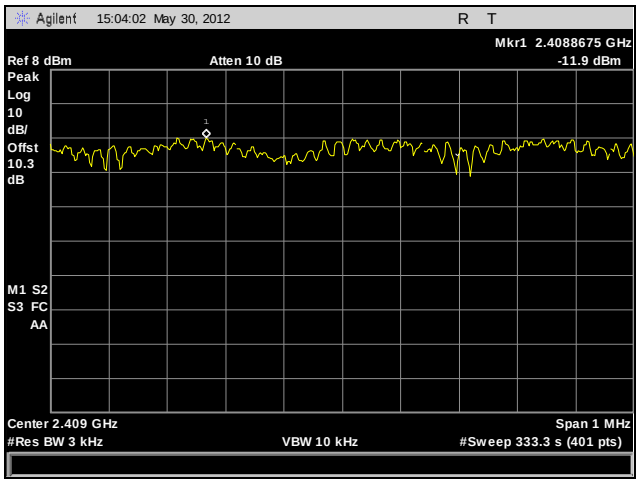


Plot 135. Peak Power Spectral Density, Mid Channel, 802.11g

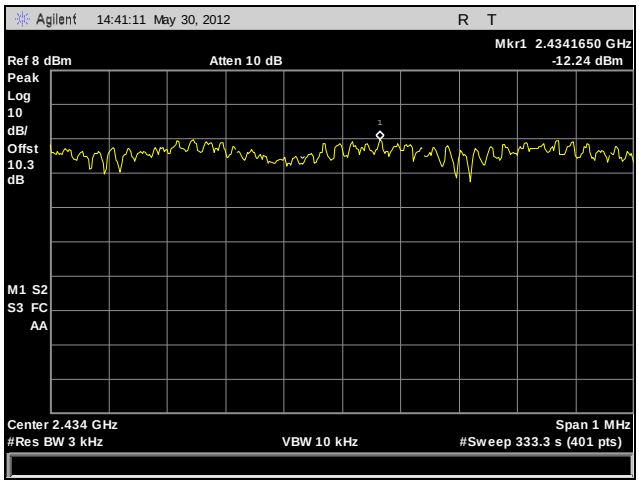


Plot 136. Peak Power Spectral Density, High Channel, 802.11g

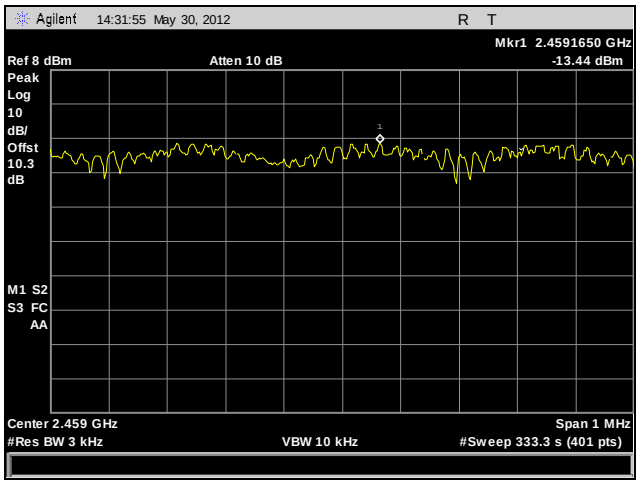
Peak Power Spectral Density, 802.11n 20 MHz



Plot 137. Peak Power Spectral Density, Low Channel, 802.11n 20 MHz

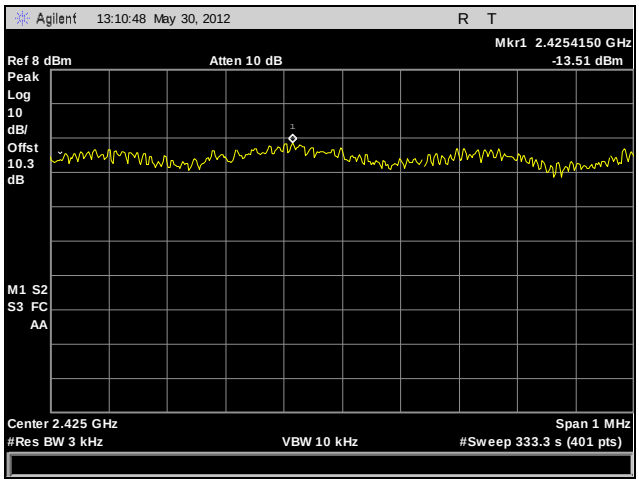


Plot 138. Peak Power Spectral Density, Mid Channel, 802.11n 20 MHz

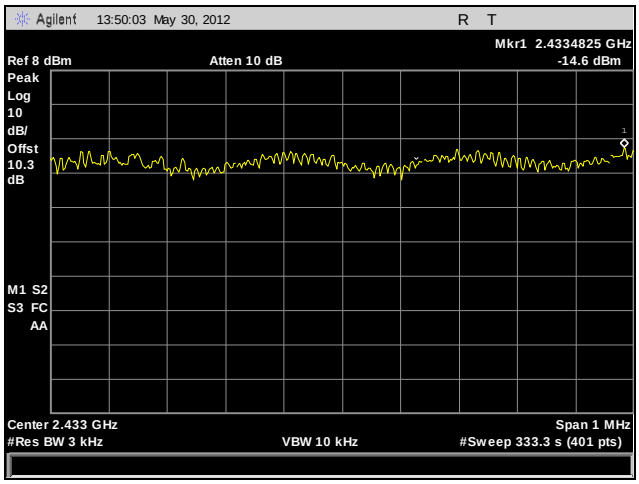


Plot 139. Peak Power Spectral Density, High Channel, 802.11n 20 MHz

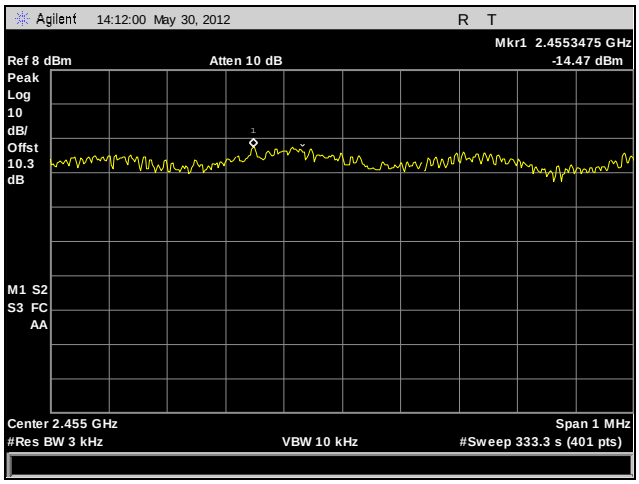
Peak Power Spectral Density, 802.11n 40 MHz



Plot 140. Peak Power Spectral Density, Low Channel, 802.11n 40 MHz



Plot 141. Peak Power Spectral Density, Mid Channel, 802.11n 40 MHz



Plot 142. Peak Power Spectral Density, High Channel, 802.11n 40 MHz

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(i) Maximum Permissible Exposure

RF Exposure Requirements: **§1.1307(b)(1) and §1.1307(b)(2):** Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

RF Radiation Exposure Limit: **§1.1310:** As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

MPE Limit Calculation: EUT's operating frequencies @ 2412-2462 MHz; highest conducted power = ***24.93dBm*** (peak) therefore, **Limit for Uncontrolled exposure: 1 mW/cm^2 or 10 W/m^2**

EUT maximum antenna gain **= *1.2 dBi.***

Equation from page 18 of OET 65, Edition 97-01

$$S = PG / 4\pi R^2 \quad \text{or} \quad R = \sqrt{PG / 4\pi S}$$

where, S = Power Density (1 mW/cm^2)
P = Power Input to antenna (311.17mW)
G = Antenna Gain (1.32 numeric)

$S = (311.17*1.32/ 4*3.14*20.0^2) = (410.20 / 5024)$ = **0.082 mW/cm^2**@ 20cm separation

Electromagnetic Compatibility Criteria for Intentional Radiators

RSS-GEN Receiver Spurious Emissions Requirements

Test Requirements: The following receiver spurious emission limits shall be complied with:

(a) If a radiated measurement is made, all spurious emissions shall comply with the limits of Table 25.

Spurious Frequency (MHz)	Field Strength (microvolt/m at 3 metres)
30 – 88	100
88 – 216	150
216 – 960	200
Above 960	500

Table 25. Spurious Emission Limits for Receivers

(b) If a conducted measurement is made, no spurious output signals appearing at the antenna terminals shall exceed 2 nanowatts per any 4 kHz spurious frequency in the band 30-1000 MHz, or 5 nanowatts above 1 GHz.

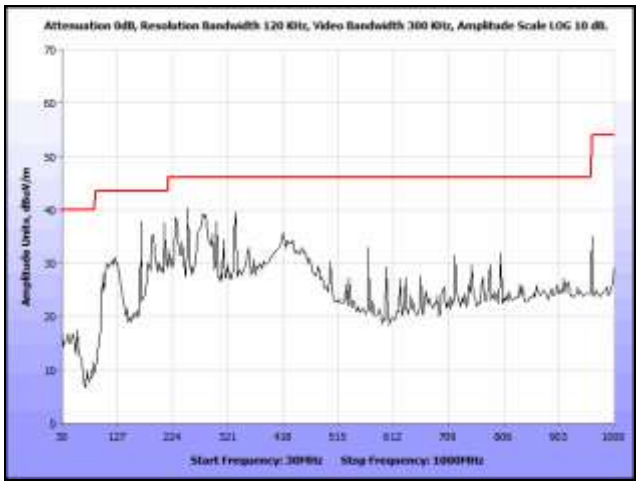
Test Procedures: The EUT was programmed for receive mode only. 120 kHz resolution bandwidth was used from 30 MHz - 1 GHz and 1MHz resolution was used for measurements done above 1 GHz. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor, cable loss, preamp and distance and compared to a 3 m limit line.

Test Results: Equipment is compliant with the Receiver Spurious Emissions Requirements of RSS-GEN.

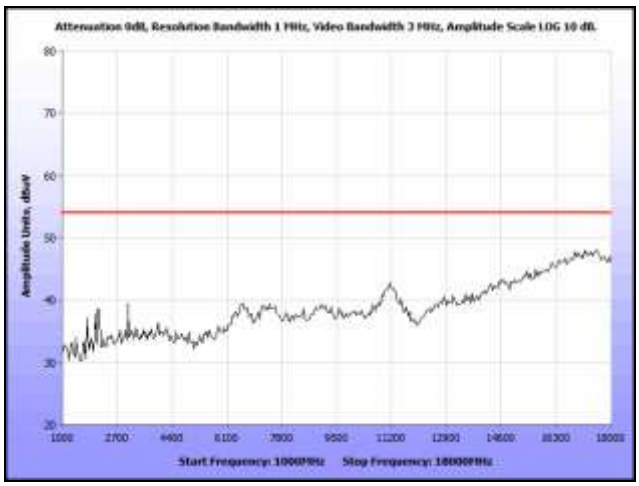
Test Engineer(s): Anderson Soungpanya

Test Date(s): 05/23/12

Radiated Receiver Spurious Emissions



Plot 143. Receiver Spurious Emission, 30 MHz – 1 GHz



Plot 144. Receiver Spurious Emission, 1 GHz – 18 GHz

Radiated Receiver Spurious Emissions Setup Pictures

Photograph 10. Radiated Spurious Emissions, Test Setup, 30 MHz – 1 GHz

Photograph 11. Radiated Spurious Emissions, Test Setup, 1 GHz – 18 GHz

IV. Test Equipment

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ANSI/NCSL Z540-1-1994 and ANSI/ISO/IEC 17025:2000.

MET Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1S2603	HORN ANTENNA	ETS-LINDGREN	3117	05/09/2011	05/09/2012
1S2202	HORN ANTENNA	EMCO	3116	04/23/2010	04/23/2013
1S2583	ANALYZER, SPECTRUM	AGILENT	E4447A	03/27/2012	09/27/2013
1S2460	ANALYZER, SPECTRUM	AGILENT	E4407B	07/12/2011	07/12/2012
1S2482	CHAMBER, 5 METER	PANASHIELD	641431	11/22/2011	11/22/2012
1S2399	TURNTABLE CONTROLLER	SUNOL SCIENCE	SC99V	SEE NOTE	
1S2484	BILOG ANTENNA	TESEQ	CBL6112D	03/01/2011	03/01/2013
1S2481	10 METER CHAMBER	ETS-LINGREN	DKE- 8X8 DBL	11/6/2011	11/6/2012
1S2421	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB 7	6/17/2011	6/17/2012
1S2506	SPECTRUM ANALYZER	RHODE & SCHWARZ	1164.4391.30 FSP	6/20/2011	6/20/2012
1S2583	SPECTRUM ANALYZER	AGILENT/HP	E4447A	3/27/2012	9/27/2013
1S2198	HORN ANTENNA	EMCO	3115	9/29/2011	9/29/2012
1S2485	BILOG ANTENNA	TESEQ	CBL6112D	5/17/2011	5/17/2012

Table 26. Test Equipment List

Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.

V. Certification & User's Manual Information

Certification & User's Manual Information

A. Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

§ 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

(a) The various types of radio communication transmitting devices described throughout this chapter.

(b) The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.

(c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.

(d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

§ 2.803 Marketing of radio frequency devices prior to equipment authorization.

(a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:

(1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or

(2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.

(d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.

(e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:

(i) Compliance testing;

(ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or

(v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.

(e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.

(f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.

Certification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J — Equipment Authorization Procedures:

§ 2.901 Basis and Purpose

(a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.[1] *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer*, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.

(b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

§ 2.907 Certification.

(a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.

(b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

[1] In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart B (of Part 15), which deals with unintentional radiators.

Certification & User's Manual Information

§ 2.948 Description of measurement facilities.

(a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.

(1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.

(i) If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.

(ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.

(2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.

Certification & User's Manual Information

1. Label and User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart A — General:

§ 15.19 Labeling requirements.

(a) In addition to the requirements in Part 2 of this chapter, a device subject to certification or verification shall be labeled as follows:

(1) Receivers associated with the operation of a licensed radio service, e.g., FM broadcast under Part 73 of this chapter, land mobile operation under Part 90, etc., shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

(2) A stand-alone cable input selector switch, shall bear the following statement in a conspicuous location on the device:

This device is verified to comply with Part 15 of the FCC Rules for use with cable television service.

(3) All other devices shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

(4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.

(5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

§ 15.21 Information to user.

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Verification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart B — Unintentional Radiators:

§ 15.105 Information to the user.

(a) For a Class A digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at own expense.

(b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

– Reorient or relocate the receiving antenna.

– Increase the separation between the equipment and receiver.

– Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

– Consult the dealer or an experienced radio/TV technician for help.

ICES-003 Procedural & Labeling Requirements

From the Industry Canada Electromagnetic Compatibility Advisory Bulletin entitled, "Implementation and Interpretation of the Interference-Causing Equipment Standard for Digital Apparatus, ICES-003" (EMCAB-3, Issue 2, July 1995):

> "At present, CISPR 22: 2002 and ICES technical requirements are essentially equivalent. Therefore, if you have CISPR 22: 2002 approval by meeting CISPR Publication 22, the only additional requirements are: to attach a note to the report of the test results for compliance, indicating that these results are deemed satisfactory evidence of compliance with ICES-003 of the Canadian Interference-Causing Equipment Regulations; to maintain these records on file for the requisite five year period; and to provide the device with a notice of compliance in accordance with ICES-003."

Procedural Requirements:

According to Industry Canada's Interference Causing Equipment Standard for Digital Apparatus ICES-003 Issue 4, February 2004:

Section 6.1: A record of the measurements and results, showing the date that the measurements were completed, shall be retained by the manufacturer or importer for a period of at least five years from the date shown in the record and made available for examination on the request of the Minister.

Section 6.2: A written notice indicating compliance must accompany each unit of digital apparatus to the end user. The notice shall be in the form of a label that is affixed to the apparatus. Where because of insufficient space or other constraints it is not feasible to affix a label to the apparatus, the notice may be in the form of a statement in the user's manual.

Labeling Requirements:

The suggested text for the notice, in English and in French, is provided below, from the Annex of ICES-003:

> This Class [2] digital apparatus complies with Canadian ICES-003.
>
> Cet appareil numérique de la classe [1] est conforme à la norme NMB-003 du Canada.

[2] Insert either A or B but not both as appropriate for the equipment requirements.

End of Report